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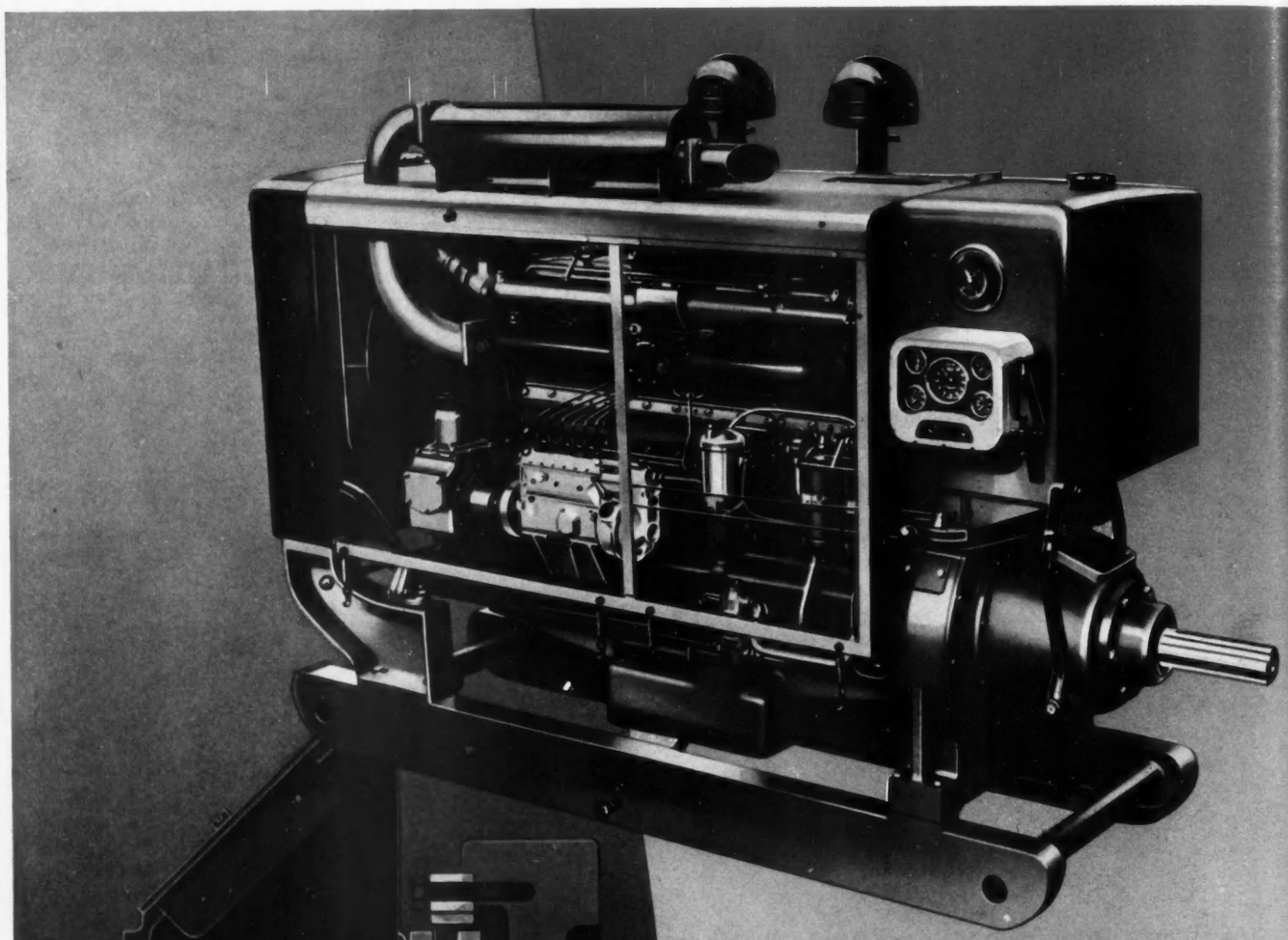

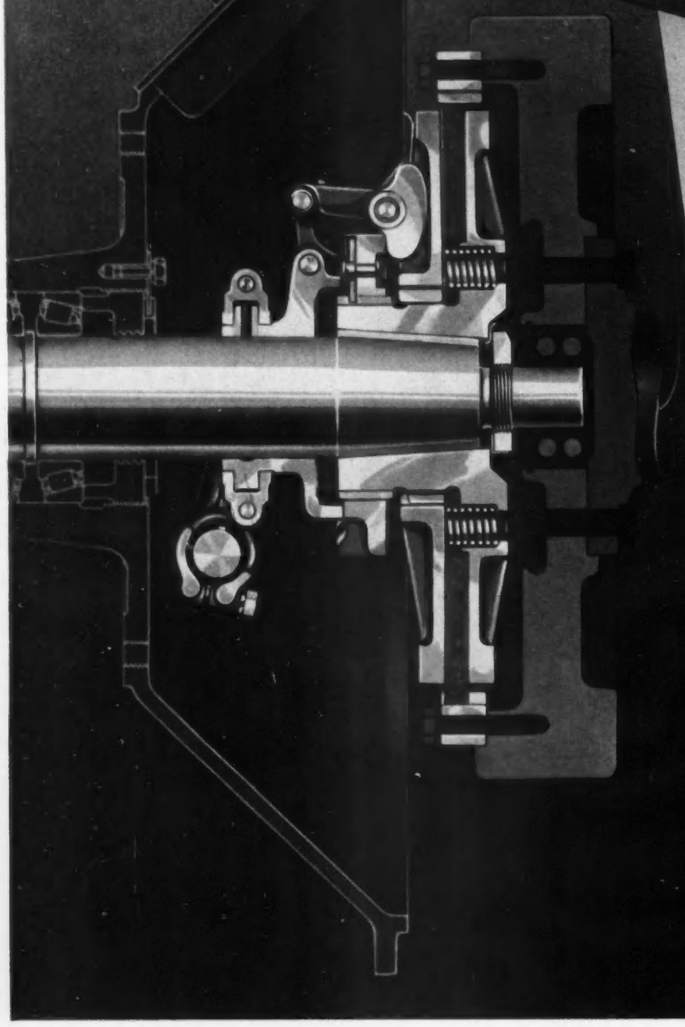

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ENGINEERING

An Illustrated Weekly Journal

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DIP. TECH.

IMPROVEMENTS in the pattern of technological education have been the subject of delicate negotiations in the United Kingdom for several years. The conduct of the negotiations has resembled the conduct of international diplomatic negotiations: in Sir Anthony Eden's phrase—"open covenants secretly arrived at." Preliminary details of a new agreement were announced by the Minister of Education, Sir David Eccles, last week, though to call it an agreement is probably too optimistic as the announcement has precipitated urgent discussions between representatives of organisations intimately affected. The Minister's plans will almost certainly be criticised.

The plans provide for establishing a scheme for awarding Diplomas in Technology to students who have taken an approved course at a technical college. Engineering is a branch—the main branch—of technology covered by the scheme, and provision is also made for "technologies other than engineering." The scheme is based on proposals submitted to the Minister last year by the National Advisory Council on Education for Industry and Commerce; the text of these proposals is given on page 127 of this issue, although it is likely that there will be minor differences in the scheme as implemented. At all events, the Minister said that a National Council for Diplomas in Technology is being set up, with Lord Hives, chairman and joint managing director of Rolls-Royce Limited, as chairman. This Council will establish conditions and standards which will make the diplomas the equivalent of university degrees in the higher technological field. There will be eleven members of the Council, in addition to the chairman, comprising five appointed by the Minister and three appointed by each of two boards of studies. One board of studies, for engineering, will consist of 28 members (five nominated by the Minister and 23 by professional and other institutions); and the other board, for technologies other than engineering, will have five nominated by the Minister and 21 by professional and other institutions. The boards will carry the burden of the tremendous work involved.

In the House of Commons the Minister was asked by Mr. Austen Albu "whether he has made any alteration to his original plan in conformity with the views of the professional associations and almost all informed opinion in industry, which is very critical of what he proposes to do?" The Minister replied: "I have taken considerable trouble in the last two months to confirm my previous view that industry was on my side, and all the investigations I have conducted show that industry very much wants an award which will attract young men and young women to sandwich courses in higher technology."

The three major engineering institutions are opposed to the scheme. They have had discussions with the National Advisory Council, of which Sir Ronald Weeks is chairman, but major differences of principle remained. The institutions have declared, in the annual report of the Institution of Electrical Engineers, that they insist on three main points: briefly, that (1) at the outset only a small number of colleges in which the necessary standards could be assured should be recognised for the new courses and that the limited teaching resources should be concentrated in them; (2) the control of conditions leading to the award should be in the hands of those who are professionally qualified to adjudicate; (3) that the award in engineering should have a title which is readily distinguishable from that used for secondary technologies, to avoid the risk of confusing the public by the existence of varying academic standards. The three institutions subsequently received the support of other professional institutions, but it is now clear, from last week's announcement, that the Minister favours the recommendations of the National Advisory Council. Since making his announcement he has invited the institutions to nominate their representatives to the boards of studies.

It is virtually impossible to discover the whole truth concerning current negotiations. There have been formal expressions of opinion, as in the I.E.E. annual report and in Parliamentary debates during the past few years, but with so much in the balance most of the balancing and weighing is done confidentially. It may be that a more open expression of views would only complicate a situation that is already regrettably complicated, but it might encourage a clearer exposition of the ultimate purpose of changes in technological education. It has been stated in *The Times* that "the general plan is to ensure that there shall be a ladder of progress enabling any worker to study to the limit of his ability and enterprise." That is an ideal which accords with the present-day conception of education, and it may be used to assess the quality of the Minister's plan, but there is a more vital facet. The urgent national need is to ensure that in the next few decades the whole educational system turns out men and women with various types of education in the right proportions and in the right quantities (Professor James Small's letter in this issue touches on this factor). The National Diploma scheme—and any objections to it—must be judged in the light of this overriding necessity.

Weekly Survey

Cover Picture. *Reference to the photograph of the glider is made in an article on page* 126.

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BRITAIN'S NUCLEAR CONTRIBUTION AT GENEVA

Sixty-seven papers dealing with such diverse subjects as power production and radiotherapeutics will be read by British scientists at the international conference on the peaceful uses of atomic energy, to be held at Geneva from Monday, August 8, to Saturday, August 27. More than a thousand papers have been submitted by all the countries taking part.

At the same time there will be two exhibitions, at which British exhibits will occupy some 30,000 sq. ft.; contributions will be made both by the United Kingdom Atomic Energy Authority and by firms representing instrument manufacture and heavy industry.

One of the exhibitions, in the Palais des Nations, is purely scientific and intended principally for members of delegations. The Atomic Energy Authority's display, covering 3,000 sq. ft., will be mainly concerned with nuclear reactors for research and for the generation of power, and with specialised instrumentation developed in this field. Models of one of the Calder Hall reactors, of the Harwell heavy-water reactor E443 now being built, and of the second Harwell heavy-water reactor RE775 also under construction, are to be included. These last two reactors are known as " Dido " and " Pluto."

The second exhibition, in the Palais des Expositions, is designed for both the general public and delegates. The U.K.A.E.A. exhibit will be a comprehensive survey of the peaceful applications of atomic energy in this country and will occupy 7,000 sq. ft. There will be a detailed model of the Calder Hall power station covering an area of approximately 17 ft. by 4 ft., and one of the breeder reactor experimental power station at Dounreay. Dido will be shown here in a model 19 ft. by 15 ft. and nearly 6 ft. high.

A wide range of models and working apparatus will tell of the latest advances in the use of radioactive isotopes, of which Britain is the largest exporter in the world. Much of the display will be devoted to industrial and medical applications but their place in agriculture will also be represented.

About 35 British firms will be among the exhibitors and their displays will occupy some 20,000 sq. ft. Industry will be represented on the official British delegation, which will include Sir John Cockcroft, Sir Christopher Hinton and Sir George Thomson, by Dr. Willis Jackson, of Metropolitan-Vickers Electrical Company.

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THE AUSTIN GAS-TURBINE CAR

When Sir Leonard Lord took the quick decision to allow the Austin turbine car to join the cavalcade of historical Austin vehicles at the company's Silver Jubilee celebrations on July 9, he gave 35,000 spectators a brief official view of a car which has already covered many thousands of miles on the road for the past year. Usually it passes unnoticed, for the only thing distinguishing it from a normal Austin Sheerline saloon is the presence of four wire grids in the top of the bonnet and a nose lengthened by about 10 in. to allow space for the silencing baffles in the air intake duct. The turbine and heat exchanger are both accommodated under the bonnet. The car bears the appropriate registration number TUR 1.

The power unit gives 125 brake horse-power. It has a two-stage compressor driven by a three-stage compressor turbine followed by a separate power turbine and cross-flow heat exchanger. The exhaust is led away under the car through two ducts in the position of normal exhaust pipes, but larger. Standing close behind the car when the engine is running, one feels a large volume of warm air coming back but the temperature is not high enough to cause discomfort.

The interior is similar to a normal Austin Sheerline saloon but there are only two pedals, accelerator and brake, and there are a number of extra dials on the instrument panel. A small gear lever gives forward and reverse gears, there is a small wheel on the facia to control fuel cut-off and on the steering column there is a lever working in a quadrant to control the engine idling. Three years ago details were published of a patent by Austin's to reduce fuel consumption when idling by cutting off several combustion chambers and directing the gas from a single chamber through symmetrically-arranged nozzles to equalise thrust at the turbine wheels. At the same time the output of the centrifugal compressor was to be reduced by a movable shroud controlled by a hydraulic piston. The way in which the engine speed and sound increase in stages when the motor is being started suggests that some such scheme is now in use.

The revolution counter reads up to 25,000 r.p.m. and there are temperature indicators reading up to 250 deg. C. for turbine front and rear bearings and the compressor bearing. There are also two thermometers reading up to 1,000 deg. C. for the turbine inlet temperature. Running across the front of the car is a large oil cooler which can just be seen below the front bumper.

Turbine development at Austin is carried out by a small staff of 12 engineers under the leadership of Dr. J. H. Weaving. They have their own machine shop, but they can, of course, call on the main tool room for help in making experimental power units. So far there is only one turbine car on the road, and there are no plans yet for production.

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EUROPEAN MANAGERS' AMERICAN VISIT

One of the most astounding aspects of the stream of generous actions by the United States, which was started by the Marshall Plan, was the wide dissemination of knowledge of the techniques by which American industry had become the most productive in the world. Although American civil aid to European countries has ended, these technical benefits continue, for part of the local currency counterparts of Mutual Security Aid are to be spent on research and education for these purposes. The O.E.E.C., which started as the executive agency of the Marshall Plan, has established a European Productivity Agency, and this has just held a conference in Paris on the promotion of industrial engineering and management education to be taught at university level.

That industrial engineering plays a large part in American factories is one of the findings of four groups of junior managers who attended courses in two American universities in the years 1951-52, and 1952-53, under the auspices of the Mutual Security Agency, and who describe what they learned in a booklet entitled *Reporting Back*, published by Management Publications, Limited. Much of what they have to say is, by now, well known to those who have followed the reports of the Anglo-American Productivity Council, but they say it clearly and freshly. They emphasise that American productivity is more the result of American attitudes than of specific techniques. These include the high social prestige of business in general and the manager in particular; the dogmatic belief in competition; the eagerness to try new things; the volume of sales; the cost consciousness in every department; the willingness to delegate responsibility to the lowest levels of supervision; the vitality of the trade unions and the care lavished on promoting good industrial relations; and the belief in management education and training. As an example of the competitive outlook, fostered by anti-trust legislation, they point out that managers of even giant corporations, in their anxiety to avoid any suggestion that they are hindering competition, welcome and encourage small-scale competitors. On the other hand, they also point out that many producers appear to be aware of the advantages to them of an imperfect market and hence the powerful " lobbies " urging Congress to maintain tariffs.

One of the surprising things in this report is that the rate of plant replacement was found to be not far ahead of British practice. The many large concerns with quantities of old and technically obsolete plant in use support the belief that American productivity is as much due to the efficient use of available plant capacity as to a high rate of replacement. On the other hand, assets are written off before the end of their useful life and sometimes re-capitalised; so that—for cost purposes—new depreciation is written off, although it is not deductible for tax. Such withholding of profits from distribution provides an additional source of working capital.

One of the features of industrial relations to which great importance is attached by American management are friendly and informal relations with their workers, but the authors of the report seem sceptical of the American ability to maintain their present high level of economic activity and the many concessions at present being granted to labour. Training is regarded as a profitable investment and it is considered essential for a production executive to have spent a period of time as a foreman. This conflicts with the findings of some previous observers who have not found this practice at all widespread, and it may be that it is a new development.

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COPPER SUPPLIES

There has been much talk of a copper shortage and of yet another major price increase—the third this year. This has been prompted largely by the major strike in the United States, which has already resulted in a great deal of confusion among fabricators in that country. The close association between the copper-producing and the fabricating industries makes it possible that fairly soon the producers will raise their prices sufficiently to attract enough copper to the United States market to enable the fabricators to get their supplies at a uniform price level. (At present some have been paying 42 cents a pound for some of their requirements, compared with 36 cents a pound quoted by the major producers.) A higher price would attract more Chilean copper and so ease the situation. The London market has for some time now been paying 40 cents a pound and therefore getting the preference of the Chilean producers.

Some degree of order may be introduced in this jungle by the expansion of productive capacity of Rhodesian producers. The Chibuluma mine (Selection Trust) will add 16,000 tons by the end of this year, and the Bancroft mine (Rhokano Corporation) 90,000 tons by 1960. This may, of course, be a drop in the ocean if demand continues to climb at the rate of the past few years. The recent efforts at price stabilisation, however, (Weekly Survey, June 3) suggest that the Rhodesian producers may not share this view. At all events, it is quite clear that copper refiners and fabricators need more stability if they are to compete successfully in export markets and give good service to their customers in this country. In the event of a continued shortage—the demand could surely be calculated without undue difficulty—the development of substitute materials will receive a very high priority.

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NATIONALISATION REJECTED

Demands for the early conversion to State ownership of a number of additional British industries and enterprises were considered on the second day of the 16th biennial conference of the Transport and General Workers' Union at Blackpool, which opened on Monday of last

week. In all, a group of no fewer than 17 resolutions had been tabled. These asked for the approval of the nationalisation of the dock industry, insurance establishments, flour-milling plants, sugar-refining plants, tea-distributing undertakings and the engineering group of industries.

Mr. A. E. Tiffin, the union's newly-appointed general secretary, invited the 870 delegates attending the conference to reject the proposals in full. He pointed out, on behalf of the union's executive committee, that even the restricted programme of nationalisation which was part of the official policy of the Labour Party, had been rejected by the majority of voters at the recent general election. Delegates, he suggested, should reject all proposals for nationalisation, other than those which were sponsored by the Trades Union Congress and those included in the Labour Party's policy statement "Challenge to Britain." These involved the public ownership of the chemical and tool-making industries and the re-nationalisation of the iron and steel industry and road-transport undertakings. The union must face up to the fact that nationalisation had not yet been so explained to the electorate as to convince them that an extension of State ownership was in the interests of the country as a whole. It was important, therefore, that the conference should not go on record as desiring to nationalise "almost everything," without really thinking about what was involved.

There was, naturally, vigorous opposition, on the part of some of those present, to Mr. Tiffin's suggestion that nationalisation policy had played any major part in the election. But the main interest of the debate which ensued lay in the revelation of an undercurrent of feeling against being employed in a State-owned undertaking. A London delegate called for a halt in nationalisation on the ground that more employees should have practical experience of working in public undertakings before advocating an extension of State ownership. In his view, conditions in public undertakings were far more difficult than in private enterprises. Another delegate, from Suffolk, also claimed to work in a nationalised industry. He said that it was all very well to speak about nationalisation and to coin well-sounding phrases, but, after practical experience, one was apt to change one's mind. On a show of hands, the general secretary's appeal to reject the proposals was carried by an overwhelming majority.

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IMPROVED TEXTILE MACHINERY

Hard economic facts in the past few years have shown that without constant effort to keep down costs the British textile industries cannot hope to maintain sales abroad, or even at home. In his recent annual statement, Sir John Hanbury, the chairman of Courtaulds, Limited, emphasising the danger of Japanese competition, states his belief that Courtaulds "yarn and staple customers here—including our own Textile Division—would be unable, however efficient they might be, to meet unrestricted Japanese competition on a major part of existing home trade." While it may be true that protection is the only complete answer to Japanese competition, higher efficiency is also important, and this has to be sought to a large extent from improved textile machinery.

The textile machinery industry, faced with falling demand for some of the more conventional products, have to depend in turn for their prosperity increasingly upon being able to offer machinery technologically in advance of their competitors. Their showing at the recent International Textile Exhibition at Brussels is convincing evidence of their success. Exhibits included the Raper automatic leveller of Prince-Smith and Stells, Limited, which, greatly reducing the number of stages prior to spinning, has now been adapted to Continental worsted practice and to the processing of long-staple synthetic textiles. A subsidiary of Courtaulds, F.N.F., Limited, who have made major contributions to increasing speed and reliability in warp-knitting in recent years, exhibited their 168-in. machine. The introduction of a wider range of equipment and in particular of a machine suitable for the American market was announced by Sir John Hanbury. The British machinery shown at Brussels covers a very wide range of types including short-process spinning machines, electronically-controlled cloth-straightening equipment, high-speed beaming and winding machines and automatic looms. Used to the fullest advantage by the British textile industry, it would achieve cost reductions which would make the British textile industries the most efficient in the world.

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EQUILIBRIUM IN SHIPBUILDING?

The output of ships during the second quarter of this year rose sharply and the performance during the first half of the year suggests that at long last the indigestion of orders from which British shipyards have suffered during the past few years is becoming less acute. Lloyd's Register Shipbuilding Returns show that the number of ships completed in the first six months of 1955 exceeded the corresponding figure for last year by 18 per cent., and that there were improvements in the number of ships launched and of ships commenced of 25 per cent., and 9 per cent., respectively. This was despite abnormally low figures for the March quarter and holds out the promise of quicker delivery next year. The volume of orders outstanding—ships for which plans have been approved or material orders, but which have not been commenced—has been halved during the past three years, falling to an average rate of about 120,000 tons a quarter since September, 1952. This is only just over one-third of the average rate of completions during the first half of this year and the time is not far off when shipowners will be able to place orders and have their ship's keel laid within a few months. The tonnage of orders outstanding is now equal to only about 3½ quarters' completions at the rate of the June quarter.

The news last week that tramp shipping freight rates are now at their highest since the peak established during the Korean War and are still rising means that a good many owners will be keen to place orders as soon as they see a reasonable chance of getting quick delivery. So far, they have been unwilling to accept the margin of uncertainty in the prices they may have to pay owing to the escalator clause inserted in their contracts. Shipbuilders will now be able to pay much closer attention to their costs, which is almost as necessary as giving quicker deliveries—in many ways the two are closely connected—to avoid a repetition of orders being placed by British shipping lines with foreign yards. The placing of orders with foreign yards will no longer be in the interests of British owners.

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INDUSTRIAL GROWTH IN NORTHERN IRELAND

The publication of the Report of the Census of Production of Northern Ireland, 1953, is a timely reminder that, since the war, industrialisation has been proceeding there at a pace greater than in most Development Areas proper. Being administered by its own government, Northern Ireland is not technically a Development Area, but has in fact received much encouragement for industrial expansion and preferences in the field of Government contracts placed by Whitehall. Over 170 companies have started production there, or have expanded their employment, since 1945. The Board of Trade announced last May that these companies are providing employment for an additional 26,000 workers, with the expectation of an ultimate increase to approximately 35,000. There remains, however, a large reservoir of labour (unemployment in 1954 averaged over 33,000) and there is an even larger "hidden" reserve in rural districts.

The Census of Production, 1953, shows that employment in manufacturing industry has increased from 139,000 in 1935 to 208,000 in 1953. Engineering and metals now constitute the largest industrial group, accounting in that year for 26·4 per cent. of the total manufacturing industry's net output, followed by textiles with 24·7 per cent., and food, drink and tobacco with 15·5 per cent. In 1935, textiles led with over 33 per cent. and engineering took third place with 15 per cent. Building and civil engineering has also shown a marked proportionate increase and accounted for 11·8 per cent. of the total in 1953.

The report also gives useful information on exports of manufactures to countries outside the United Kingdom, which in 1953 took nearly half the total gross output of manufacturing industry. The United States is the biggest foreign market, taking just over a fifth of total exports, followed by Norway, Australia, the Union of South Africa and Canada. No other country accounted for more than 4 per cent. The section "Engineering and Metals" gives useful information on the industry's products, etc., but the details of two of the most important sections—"Shipbuilding" and "Aircraft"—are hidden in the miscellaneous section "to avoid disclosure of information about particular firms." The country's dependence on Britain is still great, but the success of the large British companies who have set up factories since the war suggests that there is scope for further industrial development in Northern Ireland.

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STILL MORE STEEL

The rapid rate of growth of world capacity for the production of steel has given rise to the fear that a surplus may shortly emerge. A report by the Economic Commission for Europe, *The European Steel Market in* 1954, takes the much more optimistic view that "if there is to be a continuing and growing expansion of economic activity in the years to come, it may well be that the rate of growth of steel capacity envisaged in certain European countries is on the low side." It suggests that the time may have come to reconsider the investment plans of the European steel industry as a whole. One of the most serious threats to European steel prospects is the growth of capacity in other countries, which in the long term is likely to cause a decline in the proportion of world steel exports to total world production. This may be offset at least temporarily, however, by intensified industrialisation of the under-developed areas in Asia and Latin America where *per capita* consumption is at present extremely low. In any case, indirect steel exports in the form of engineering goods should continue to increase as direct exports decline.

A continuing high level of private and public investment in European countries and the rapid rate of expansion of personal consumption should ensure a high level of domestic demand for steel. In particular, output of motor vehicles by the four major West European producing countries is expected to rise from about 2·5 million to between 3·5 and 4 million units by 1960. Demand for cars and other durable consumer goods has already resulted in major increases in production of flat steel products, which now account for about 40 per cent. of the total rolled steel output. The achievement of higher degrees of utilisation of continuous strip mills with consequent reductions in costs and prices would further stimulate demand. As yet, however, due to inadequate steel-making and finishing facilities to match the capacity of the wide strip mills, utilisation is only 82 per cent. by modest "European" standards and 60 per cent. by "American" standards. In some countries the supply position for flat products is already very tight, and the increasingly high demand will be met only by constant effort to improve the utilisation of mills.

Facilities provided for apprentices under training with Metropolitan-Vickers include playing fields, a gymnasium, canteen, library, classrooms, games and study rooms as well as the workshop shown here, which has a floor area of 21,600 sq. ft.

APPRENTICESHIP AT TRAFFORD PARK

A GREAT TRADITION

For more than 50 years the Metropolitan-Vickers Electrical Company have developed their methods of training engineering apprentices. Long before many industrial organisations had given serious consideration to the subject, pioneering ideas had been put into practice at Trafford Park. In two previous articles we have reviewed the schemes of firms who have published apprenticeship literature during the past twelve months or so. The Metrovick system warrants an article to itself.*

"A Register of Ex-Apprentices and Ex-Trainees of the Metropolitan-Vickers Electrical Company Limited" is a "Who's Who" of all who have been trained there. The third edition, published in 1950, is a book of 682 pages containing 10,219 names of those trained between 1902 and the end of 1949. Diagrams and maps in colour show the distribution of ex-apprentices throughout the world in 1949, and also the numbers who came during those years from 76 dominions, colonies and foreign countries. It is a great tradition.

The system to-day offers flexible courses to suit differing aptitudes, education and circumstances. The apprentice's environment is a works which carries out an exceptional variety of mechanical and electrical engineering, heavy and light. The special amenities include an apprentice school and many social and educational facilities.

The Metropolitan-Vickers Education Department wase stablished nearly forty years ago to administer apprentice training schemes and to provide educational instruction. To-day, the department is responsible for training some 2,700 persons—men, women, youths and girls—and its functions include the recruitment, selection and training of all types of apprentices, numbering over 2,000, in addition to running the works school, which is recognised by the Ministry of Education.

TRAINING PROFESSIONAL ENGINEERS

The company's experience in the recruitment and training of professional apprentices dates back to its earliest years, for the first engineering graduates were admitted in 1902. To accept graduates, not for direct employment but for a thorough and broad training, was in those days a revolutionary step, and for many years it was still regarded as a novelty in the industry. The Company has thus been a pioneer in this field, and it is still in the forefront of developments, having at the present time over 770 men under training in the professional apprenticeship grades.

A small selection committee composed of senior members of the staff and members of the Education Department pays a yearly visit to universities and senior technical colleges for the purpose of interviewing engineering students. If the result of the interview is favourable the candidate is provisionally accepted for a two-year College Apprenticeship, and the acceptance is confirmed when his degree is awarded. Before starting his apprenticeship, the candidate has the opportunity of visiting the works for discussions with the staff and with graduate apprentices already in training. About 80 graduates are recruited for training from home universities each year.

The aim of the present programme of graduate engineering training is to enable an apprentice in Part 1 of the course to obtain a thorough practical experience in the factory, and to acquire—through lectures, discussions and departmental visits—experience and information from which he can determine the line of activity best suited to his talents. The main lines are design, commercial engineering, manufacturing and research.

When an apprentice proceeds to Part 2 of the course, he will thus have decided more or less on the product and the function which most interest him. Thenceforward his training will be under the authority of a departmental head. The training programme is flexible, however, both in the time required to complete any one section and in the route taken by the trainee. Specialist programmes range in scope from research metallurgy to personnel management.

SCHOOLBOY ENTRY

Professional engineering apprenticeships are also available for public-school and grammar-school boys, who leave school between the ages of 16 and 19, and these schemes also cater for young men entering industry for the first time after National Service.

Boys who leave grammar schools at the age of 16 to 17 take a five-year student engineering apprenticeship called a Special Apprenticeship. Experience is gained in workshops, test beds and other departments, and the scheme provides trained men suitable for a wide range of work as technicians. Special Apprentices take part-time technical courses on a day release basis, and those who indicate by their progress that they are likely to achieve professional qualifications are promoted to the School Apprenticeship Course described below. Approximately 45 boys are admitted to the Special Apprenticeship course each year, and the number is likely to increase.

The minimum age of entry for a School Apprenticeship is 17, and many of the candidates possess a General Certificate of Education at Advanced Level, having completed two years in the sixth form. The School Apprentice serves a four-year course and is expected to obtain qualifications that will satisfy the membership requirement of one of the professional engineering institutions.

SANDWICH AND VACATION COURSES

Since its inception some five years ago, the company has supported the works-based "Sandwich" Diploma Course held by the Royal Salford Technical College, and at the moment over 50 apprentices drawn from the School, Special, and Trade Apprentice Courses are taking the sandwich course. A large number of these men hold scholarships or special prizes awarded by Metrovick, and it is the company's intention to extend the range of such scholarships for these grades of trainee.

The principle of pre-university training for the professional engineer is now widely accepted, but it is worth recording that Metropolitan-Vickers introduced this type of training as the Probationary College Apprenticeship Course, established in 1929. Since that date and excluding the war years, over 500 public-school and grammar-school boys have been trained in this

Apprentices can take part in a wide range of social, cultural, athletic and educational activities, which they organise themselves. This lounge, decorated in pleasant contemporary style, is part of "Kenwood," the headquarters of the apprentice club.

* ENGINEERING, vol. 178, page 484 (1954), and vol. 179, page 296 (1955).

way; the course includes first a year of pre-university workshop experience, then, in accordance with the conditions of the apprenticeship, leave of absence to follow a full-time university degree course, and after graduation a further year at the works to complete their training. About 35 boys are at present accepted for Probationary College Apprenticeship each year.

About 120 university students from home and abroad attend an eight-week Vacation Apprenticeship Course held at the works each summer. It starts with two weeks intensive workshop experience in the Apprentice Training School followed by practical experience in one or more of the company's main manufacturing departments; lectures by senior members of the staff give a comprehensive picture of the company's organisation. In addition, some 25 public-school and grammar-school boys are taken for a short Easter Vacation Course; these are fifth-formers or first-year sixth-formers who think that engineering may be their chosen career.

Of special note is the part played by Metrovick in training overseas engineers. At the present time there are over 180 men from abroad undergoing training, representing 39 countries, colonies and states.

In the training of all grades of professional engineers, extensive use is made of the facilities provided by the company's Apprentice Training School. The school covers an area of 40,000 sq. ft., of which 21,600 sq. ft. are the main workshop; illustrated opposite. The remaining area is devoted to stores, canteen, kitchen, library, reading room, class rooms, indoor games room, and various offices. Adjoining the school there are some ten acres of playing fields, and in another part of the company's premises is a fully-equipped gymnasium.

LEISURE

Apprentices of all grades are eligible for membership of the Apprentice Association, which consists of a college and school section and a trade section. The association is controlled by a representative committee the main functions of which are to promote good fellowship among the members, to negotiate with the company's representatives, and to organise athletic, educational and social activities. Each section also has its own committee, which, meeting every week, represents the interests of the section members and is responsible for the organisation of a wide variety of activities ranging from dances to technical lectures, from the publication of *The Rotor*—the apprentices' quarterly magazine—to athletic activities.

Since last November when an apprentice club was opened at "Kenwood"—a large house, which has been gracefully decorated in a bright contemporary manner—apprentices have had their own venue for many of these activities. The accommodation there includes an assembly room, a lounge (also illustrated), a refreshment room, and a study.

Although the apprentices themselves can justly take some of the credit for the continued success of the Metrovick apprenticeship scheme, it is the company which established and nurtured it. Not the least of those responsible for its growth and development was Sir Arthur P. M. Fleming, C.B.E., who, in 1908, centralised the apprentices training, and to-day the work is carried on in the same spirit. Dr. Willis Jackson, Director of Research and Education at Metropolitan-Vickers, speaking of the 30 per cent. discrepancy between the supply and demand of engineering graduates, said that, although 45 per cent. of university students read scientific or technological subjects, this did not represent the distribution of ability; for various reasons many more capable boys were drawn to the humanities.

In meeting this shortage and encouraging young people to consider engineering as a career, apprentice training schemes can play an important part. It may thus be said that the work of Metropolitan-Vickers in this field not only represents a great tradition but is also a great example.

Letters to the Editor

RECRUITMENT OF GRADUATES TO INDUSTRY

SIR, Having been away from my desk for a time I have delayed acting upon an intention to comment on your leading article of July 1, "Bricks Without Straw." If even at this late date I raise one or two of the points which I have already made in an article on technological recruitment in *The Times Educational Supplement* on June 10, I may perhaps be forgiven because of their relevance.

In more than doubling the number of their students reading science and technology the universities have done more than the bare statement of that simple fact conveys, for they have done it in face of a reduction between 1931 and 1953 of one and a half millions in the population age-group 15-29 from which the student element is drawn. There is now evidence that not many who have the urge and the ability to enter university degree courses are unable to do so because of stringency of means or for other reasons. This might seem to lend urgency to the desire expressed in some quarters, and implied in your article, for diverting students from arts to science and engineering as a means of relieving the situation. Something might come of such a policy. For the present we may reflect that employers are not always careful to put their recruits to those jobs in which the fullest use can be made of the technical and scientific element in their mental equipment. Indeed, of the many openings that the university schools of engineering are asked to fill in industry a considerable proportion are such that the candidates' technical attainments are of secondary importance. Employers are frequently not greatly concerned about a degree for its own sake; they often regard it rather as an assurance that the prospective entrant to their employment has the personal qualities that the discipline of a university course is expected to impart to a man. This is reasonable enough when they are dealing with that category of post in which, given the necessary endowment of intelligence, the novices' usefulness depends entirely on what he learns on the job itself. In this case it little matters whether his degree is a science one or an arts one.

It is not my intention to tout for the arts man; but it is desirable that our scientific strength should be conserved and directed to our scientific needs. If an employer has a job in which an arts man will do, why choose an engineer?

A corollary is that the designer and the development and research engineer, working on problems to which their training is directly relevant, should have hopes of rising to that level of remuneration which at present seems so often to be attainable only by the salesman, the advertiser and the "business executive," who are even now frequently recruited from fields of training outside engineering.

An allusion is made in your article to the Atomic Energy Authority. It is a privileged competitor in the market for trained men. Doubts are now being raised about the policy which enables it even to strip the universities of the teachers on whom the production of graduates, so much in demand, depends. It shares, too, with some sections of the aircraft industry and certain Government laboratories, a position of privilege in relation to the National Service obligations of its young recruits. This invidious situation calls for study. For although atomic energy and aircraft are of undeniable importance and may, or may not, decide our future, it is clear that for the present our economic life depends on the fullest possible development of the less spectacular and the traditional industries of the country.

Yours faithfully,

JAMES SMALL.

James Watt Engineering Laboratories,
The University,
Glasgow.
July 18, 1955.

GAS AND STEAM TURBINES

1954 REPORT OF PAMETRADA

The progress report for 1954 of the Parsons and Marine Engineering Turbine Research and Development Association has recently been published and provides a comprehensive summary of work carried out during the year. Among the subjects covered are gas and steam turbine technology, gearing, boilers, instrumentation, transmission and the development of various new techniques. The survey also includes administrative, financial and technical committee reports; research and contract reports; and details of an instructional course on marine geared steam-turbine machinery, while patents granted or applied for, and papers delivered or translated during the period are listed in appendices. Possibly the most interesting research projects dealt with in the report concern the cooled gas turbine and the high-temperature steam turbine, and this work is described in the present article.

HIGH-TEMPERATURE STEAM TURBINE

In the construction of the high-temperature steam turbine, Pamela, the first-row shrouding was made in a number of different materials in order to gain experience of the durability of such shrouding at high steam temperatures; in addition an attempt was made to weld the shrouding in place, but this was not satisfactory as it proved impossible to test the soundness of each blade weld non-destructively. Owing to repeated failures of the driving-turbine first-stage shrouding over the F.D.P. blade pack, only some 80 hours' running has been completed during the year. Meanwhile new first-stage blading has been ordered, and distortion test work is continuing with the first-stage unshrouded until this is delivered.

Several attempts to obtain reliable power and efficiency results have proved unsatisfactory since it was impossible to obtain a correlation between driving-turbine heat drop, brake-turbine heat rise and the power measured by torquemeter. Extensive changes have been made to correct this. Consistent casing-distortion results were obtained from a number of controlled steam temperature change tests and it is likely that this work will be continued.

Pipe thrusts from the main exhaust line caused the brake casing to become misaligned with the bearings. The brake-turbine casing was therefore stiffened by welding up the side support plates, and in addition the expansion arrangements of the exhaust range were modified. A novel form of hinged bellows was tested; these permitted deflection in two planes and thus reduced the number of hinged joints by one. These modifications have proved satisfactory.

New combustion equipment was fitted to a boiler which underwent trials in conjunction with the turbine tests. This equipment has not proved entirely satisfactory, but tests have now shown that only a minor modification is required. The combustion equipment on the second-stage superheater has prevented satisfactory operation at full steam superheat and throughput. Work on this is continuing.

LIQUID-COOLED GAS-TURBINE BLADES

Every effort has been made to accelerate the development of the liquid-cooled high-temperature gas turbine and considerable progress has been achieved with the first single-stage turbine, not only in its construction but also with ancillary investigations and the preliminary testing of components. It is expected that the complete

turbine will be erected ready for testing very shortly.

Among the problems encountered and overcome during construction of the turbine were distortion and weld porosity in the inlet casing, and some minor design alterations were proposed. It is now being fitted with lining bricks, and in addition the blade casing, which is a Hiduminium casting, has been fitted with lining bricks and refractory nozzles. The nozzle-holding bricks are located peripherally by three semi-cylindrical strips; these have proved inadequate and additional locating stops are to be used. After several trials of prototype exhaust-duct cooling sprayers, an atomiser system was selected as most satisfactory. Compressed air has been mainly used as the operating medium, and some of the valves were specially designed.

One of the most important aspects of the work is the collection of information on the two-liquid system of cooling the rotor blades. At the beginning of the year the rig for obtaining the basic data was complete, but it remained to develop a heater construction able to withstand high temperature and large rotational forces and at the same time produce a heat input of up to 1 kW over a blade surface area of 1½ square inch.

Much effort was expended on this problem and the best heater construction achieved consisted of resistance wire held in position and insulated by refractory cement. Even with this method the heaters would not withstand inputs of more than 0·7 kW, even when the blade surface temperature was not high, probably because the heater wire is very much hotter than the blade surface when the heat input is high, owing to the low thermal conductivity of the layer of insulating cement between the wire and the blade surface. Fortunately, this does not mean that results applicable to higher heat loadings are unobtainable.

First tests were made with water in the blades and runs were carried out at various speeds up to 6,000 r.p.m. over a range of heat inputs and with different quantities of water in the blades. At the higher heat inputs the water would certainly be boiling in the heated section and condensing in the cooled root, and very effective cooling was obtained. However, liquid-metal blade fillings (such as mercury and sodium-potassium alloy) appeared to have advantages over water in that high vapour pressures would not arise inside the blade, and furthermore, the possible limit to the heat-flow rate into water set by the onset of film boiling would not apply to the liquid metals.

The single-stage turbine rotor blades had been designed with one large internal cooling passage. A number of blades were pressure tested to determine whether in fact water, with its high vapour pressure, could be used as filling, but it was shown that the blades would be working above the safe bursting stress. The provision of a central strengthening web in the blades was considered, but it was clear that this could not be produced in the cast blades. It was decided, therefore, to retain the existing blade design for the first rotor and to use liquid metal-alloy as the filling.

CERAMIC NOZZLES

Blades—mainly of zircon with a 2½ per cent. addition of chromic oxide—for the single-stage turbine were tested throughout the year. Excellent thermal shock resistance was obtained but the creep strength was found to be low at 2,200 deg. F., and it became clear that the long-term prospects of this material were poor. In the meantime, the Morgan Crucible Company, Limited, 52 Battersea Church-road, London, S.W.11, who had developed the zircon-chromic-oxide material under contract from Pametrada, had independently produced a material under the code name "I.C." which is in fact silicon carbide made by a special process.

Three blades of this material were tested towards the end of the year, and when the research report was written had run for over 360 hours, with 16 thermal shocks. There was no sign of distortion or cracks but the surface had roughened appreciably and a few glassy patches developed. A careful check on the blade weight indicated that slight increases occur during running at 2,200 deg. F., but at 2,100 deg. F. and below there was no change.

"Metamic" (metal ceramic mixture) blades were also offered for test by the Morgan Crucible Company, with chromium and alumina as constituents. These showed excellent thermal shock resistance, but at 2,200 deg. F. their strength was even less than that of the zircon-chromic-oxide material and they warped very rapidly. Preparations are in hand, however, to test further metamics with a higher proportion of alumina.

COMBUSTION CHAMBER

The combustion chamber to be used on the experimental turbine is of a novel design, incorporating four flame tubes which exhaust into a central mixing zone. This enables them to be lit or shut down one at a time, thus mitigating the thermal shock on the refractory nozzle blades and also easing the problem of changing a faulty sprayer without shutting down the engine. A further advantage from the design point of view is that the flame tubes need not be all alike, and several designs can be developed simultaneously.

Development tests were performed on a number of different flame tubes; these included one refractory-lined and two air-cooled designs. The refractory-lined flame tubes have worked quite well, but the cooling arrangements in both air-cooled designs have proved inadequate and overheating of the flame tubes and branch casings has occurred. Further types of air cooling are being developed by Pametrada. The fuel system consisted of four spill-controlled sprayers taking fuel from a common manifold at a constant supply pressure, with the output controlled by a throttle valve in the common spill line.

It was found that the torch igniters could be relied upon to work over a wide range of air flows and damper settings, but trouble was encountered due to decomposition of the trapped fuel. Tests showed that this could be overcome by mounting the torches in air-cooled housings and this is now being put into practice.

Design studies put in hand during the year included the development of liquid-cooled rotor arrangements alternative to the present welded construction and assessment of the possibilities of liquid-cooled stator blades. The effect on overall thermal efficiency and cooling loss of a full-scale turbine of variations of opening/pitch and pitch/chord ratios was also investigated. In addition, at the request of the Admiralty a design was prepared for a set of air-cooled stator blades for use in place of ceramic blades for the single-stage turbine. Extruded Nimonic blading was to be employed and provision was made for thermal expansion, and for disposing of the air into the gas stream.

MEASURING ROTOR-BLADE TEMPERATURE

Alternative methods of blade manufacture have been extensively studied. In general, it is possible to machine the exterior of any blade, but forming the interior cooling passages is a more difficult problem. Both spark and ultrasonic machining have proved impracticable for this purpose, but a third method whereby one end of a thick-walled tube, with the desired interior profile, is electro-upset to form the blade root is being examined.

The largest single item in the instrumentation programme for the turbine has been a method of measuring rotor-blade temperatures. Earlier work had shown that Quigley cement was strongly adherent to metals and possessed good electrical resistance up to temperatures higher than those at which the blades operated. It had also been observed that Stellite 7 possessed consistent thermoelectric properties making it suitable as a thermocouple material. Stellite-Constantan thermocouples were thus selected for use, with single Constantan wires of 0·005-in. diameter cemented into 0·01-in. wide by 0·01-in. deep grooves in the blade surfaces, and the wire spot-welded to the Stellite at the end of the groove.

This method has two main advantages. Since all the Stellite blades are in contact, only one connection from Stellite to the external indicating instrument is needed. Using 18 sliprings, 17 separate blade temperatures can be measured, and a fairly complete determination of the blade temperature distribution can be made. In addition, single wires only have to be fitted to the blades; the grooves are small; the reduction of blade strength is slight; and both the disturbance of blade temperature distribution and uncertainty in the position of the thermocouple junction are minimised.

BEARINGS UNDER OIL FAILURE

Also during the year an attempt has been made to produce a bearing, particularly for turbine use, which under conditions of lubricating-oil supply failure would be capable of supporting the rotor without damage to the journal, blading or glands, while the turbine runs down to stop; and then will allow the turbine to run up to speed again on resumption of the oil supply without the need to strip down the bearing.

The normal safety-strip bearing was found to be unsatisfactory, but bearings were made in which the safety strip occupied in effect almost the whole width of the bearing behind the white-metal, and these, with a copper-tin sinter as safety layer, have been recommended for turbine use. During tests on a steel-backed bearing without safety strips, it was observed that, although during failure a temperature sufficient to distort the steel backing was reached, the journal was scored but no seizure occurred; the molten whitemetal acted as a lubricant.

A bearing in which the cooling function was separated from the lubricating function of the oil by means of sinter has been run at speeds up to 130 ft. per second under specific loads up to 600 lb. per square inch. The losses were found to be very low in comparison with those of fully lubricated bearings of equivalent dimensions. Journal-bearing performance when lubricated from a directly driven oil pump has been studied, and it appears that from the bearing aspect alone this is a satisfactory method of lubrication at all speeds. It may not be so, however, if it is also necessary for the bearing to carry away heat from the journal or housing; heat, that is, which has not been generated by the bearing itself.

PNEUMATIC BEARINGS

The properties of air and steam lubricated bearings have been also examined on paper, firstly to discover a type of bearing in which the load-carrying film is produced by relative movement in the bearing, as occurs in a normal hydrodynamically lubricated bearing; and secondly, one having a large number of lubricant inlets. A design for an experimental air bearing for test during 1955 is being prepared.

These details, together with descriptions of newly developed instruments, such as a portable noise-level and vibration meter; test results for gears and torque converters; and a variety of other information associated with the study of turbines are given in the Pametrada Progress Report, which is fully illustrated and admirably produced. Inquiries should be made to the Pametrada Research Station, Wallsend.

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LITTLE BARFORD B POWER STATION

The Central Electricity Authority has received the consent of the Minister of Fuel and Power to the extension of the Little Barford power station, near St. Neots, Huntingdonshire, by the establishment of a new section, Little Barford B.

The present station has an installed capacity of 120 MW (160,000 h.p.). The extension will provide a similar capacity by two further 60-MW turbo-generator sets and two boiler units each having an evaporative capacity of 550,000 lb. of steam an hour.

Obituary

SIR RICHARD W. ALLEN, C.B.E.

SERVICE IN MANY FIELDS

By the passing of Sir Richard W. Allen, C.B.E., D.L., chairman of W. H. Allen, Sons and Company, Limited, Queens Engineering Works, Bedford, on Sunday, July 17, the company, the engineering industry and many other bodies and associations lose a friend, a great engineer and a great man. His claim to be remembered will be recognised not only by those within the Allen organisation, who had every reason to show him gratitude, but by a great number of others who can rightly pay tribute to him as a notable leader and worthy successor to his eminent father, William Henry Allen, the founder and first chairman of the company and one of Britain's pioneers in mechanical, electrical and hydraulic engineering. Sir Richard had known personally every Engineer-in-Chief of the Fleet since this post was created, and he knew, and was well-known by, the leading personalities of British shipbuilding firms and shipping companies over a period of nearly 70 years.

Although being so closely connected with the design and construction of auxiliary machinery for all classes of naval and mercantile marine vessels, Sir Richard Allen's interests extended over a very wide sphere of engineering projects on land, including pumping schemes for land drainage and irrigation, water supply and sewage disposal, as well as power generation in central stations and many industries throughout Great Britain and the world. It can be said that he was in every sense a truly " specialist " engineer, and characteristic of the tradition of a firm which has specialised in the design and construction of pumping and power generating machinery since its inception in 1880.

EDUCATION AND TRAINING

Born at Cardiff in 1867, Richard William Allen was the eldest son of the late William Henry Allen. He was educated at Christ College, Finchley, under Dr. Gallop, and his technical education was given privately under Dr. Gisbert Kapp, who was prominent in the early years of the British electrical industry, and whose work, with that of others, including W. H. Allen, did much to place dynamo design on a sound scientific basis. Subsequently, he was apprenticed to the firm which his father had founded, W. H. Allen and Company, at the original York Street Works, Lambeth, London, where the firm was engaged in a continually expanding business in centrifugal pumps under the name of " Conqueror," a name still in use to-day. The design and construction of such pumps was the original specialisation of the company, but during Sir Richard's apprenticeship days, his father was already concerning himself with the considerable possibilities in developing mechanical and electrical engineering products in association with each other. This foresight on the part of his father led within a few years to the company's active interest in the production of high-speed steam engines, gas exhausters, electric generators and motors. These rapid developments provided valuable apprenticeship experience for Sir Richard, to which he subsequently added further engineering training and experience with John Elder and Company, Glasgow (now the Fairfield Shipbuilding and Engineering Company) and also with the Naval Construction and Armaments Company, Barrow-in-Furness (now Vickers-Armstrongs Limited). In addition, he obtained sea-going experience as an engineer on board the s.s. Etruria (Cunard Line).

MOVE TO BEDFORD

By the 1890's the York Street Works, London, of W. H. Allen and Company was proving inadequate for the increasing volume of business and, after selling the site to the London and South Western Railway Company (who needed it for the building of a new Waterloo Station), W. H. Allen transferred the business to Bedford in 1894, when production was begun in August of that year at Queens Engineering Works. In that same year, 1894, the name of the company was changed, when the founder took his son Richard into partnership, and the firm became W. H. Allen, Son and Company. In 1900, the name was restyled as W. H. Allen, Son and Company, Limited, when limited liability was assumed, and later, in 1920, a further change introduced the present title of W. H. Allen, Sons and Company, Limited. From its inception the company remained a family concern until 1952, when the status of public limited liability was adopted. For a period of 32 years after the move to Bedford, Sir Richard Allen was the company's managing director, and subsequently became chairman after his father's death in September, 1926.

During the period as managing director and chairman, Sir Richard travelled extensively in both the company's and the country's interests, including four journeys round the world. For one of these round-the-world trips, Sir Richard was a British delegate for the University of Cambridge, the University of London and the Institution of Mechanical Engineers to represent these three bodies at the World Engineering Congress held in Tokyo, Japan, in October and November, 1929.

Sir Richard Allen was made a C.B.E. in 1918 and knighted in 1942. To his profession he rendered long and valued service. He was a past President of Section G of the British Association (1933); a member of the Institution of Civil Engineers; a past President of Institution of Mechanical Engineers (1927-1928) and an Honorary Member of that Institution (1931); an Honorary Life Member of the Japan Mechanical Society (1929); a member of the Institution of Naval Architects; a member of the Institution of Marine Engineers; a member of the Iron and Steel Institute; an associate fellow of the Royal Aeronautical Society; a member of the Institute of Metals; a trustee and vice-President of the Engineering and Allied Employers National Federation; a vice-President of the British Electrical and Allied Manufacturers Association; and a member of various societies connected with the Empire and agriculture. In 1906, he was awarded the Telford Premium by the Institution of Civil Engineers.

Sir Richard's special engineering interests, as already stated, concerned auxiliary machinery and equipment for H.M. Navy, foreign navies and the Mercantile Marine. He designed and patented air-supply equipment for the boiler-rooms of ships of war, and on this subject he was the author of the book *The Air Supply to Boiler Rooms for Modern Ships of War*. He delivered papers and treatises before many institutions and societies, including the following: " Surface Condensing Plants and the Value of the Vacuum Produced " (I.C.E., 1905); " Pumping Machinery in the Fens " (I.Mech.E. Summer Meeting, 1912); " Irrigation Pumping Machinery (Gezira Scheme), Sudan " (I.Mech.E., 1924); " Improved Designs of T-pieces and Bellmouths for Suction Pipe-lines of Pumping Plant in Floating Docks " (I.Mech.E., 1923); Presidential Address, I.Mech.E., 1928; and " The Air Supply to Boiler Rooms " (Institution of Engineers and Shipbuilders in Scotland, 1918).

APPRENTICESHIP SCHEMES

Like his father, Sir Richard Allen was a firm believer in technical and scientific education, and concerned himself closely with the training of pupils, students and apprentices. Thousands of them passed through the Allen system, in which Sir Richard was keenly interested, and a great proportion have become first-class engineers as the result of his direct interest and alert supervision. He was consulted on this important matter by many leading bodies in this country, including the London County Council for the Robert Blair Fellowships.

Throughout the long period of his working life, Sir Richard Allen took an active part, not only in the direction of his company, but in the affairs of the town and county of Bedford, and also in national affairs. He took a keen interest in the Industrial Welfare Society, of which he was a member of Council when King George VI (then Prince Albert) was President. He was Deputy Lieutenant for the County of Bedford, a Justice of the Peace for the County of Bedford, High Sheriff of Bedfordshire, a member of the Bedfordshire County Council for several years, a member of the Bedfordshire Standing Joint Committee and a member of the Court of Quarter Sessions.

Sir Richard Allen took a keen interest in cricket, as well as in music and the arts, and was one of the founders of the Bedfordshire Musical Festival, inaugurated in 1920. He was vice-President of this movement from the beginning until 1939, and often attended the competitions and made presentations of prizes, as well as being responsible for bringing to the festivals well-known people to help prosper this movement.

Sir Richard Allen married Geraldine Agnew, daughter of William Joseph Feddon, of Clifton, Bristol. Lady Allen, who died in 1948, consistently supported her husband in many public activities, and was known for her good work, extending over many years, on behalf of disabled soldiers and sailors. He leaves two daughters; his one son was killed during the first World War, in 1917, while serving with the Royal Flying Corps.

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P.T.F.E. PLANT

Progress at Hillhouse

Imperial Chemical Industries Limited are making good progress with a new plant at Hillhouse, Lancashire, for the production of " Fluon" polytetrafluoroethylene. When completed, the plant will have a capacity of about 200 tons, which will be achieved in two stages. The first stage, due in January, 1956, will mean that annual production of polymer is stepped up from 25 tons to 100 tons. The final 200-ton stage should be reached later in 1956. It is also planned to extend the present range to include an extrusion grade and special dispersions.

PERSONAL

SIR GORDON RADLEY, C.B.E., Ph.D. (Eng.), M.I.E.E., has been appointed director general of the Post Office, in succession to SIR ALEXANDER LITTLE, K.C.B., who is retiring on September 30.

MR. W. K. WALLACE, C.B.E., is to be President of the Institution of Civil Engineers for the session 1955-56.

SIR GEORGE H. NELSON, Bt., M.I.E.E., M.I.Mech.E., F.C.G.I., F.R.S.A., has been elected President of the Institution of Electrical Engineers for the 1955-56 session.

DR. R. COCKBURN, C.B., O.B.E., principal director of scientific research, guided weapons and electronics, since March 1, 1954, has been appointed, by the Minister of Supply, deputy controller of electronics in succession to REAR ADMIRAL G. BURGHARD, C.B., D.S.O., whose tour of duty has expired.

MR. STANLEY S. DAWES, M.I.Mech.E., F.C.C.S., has been installed for the ninth time as President of the Institute of the Motor Industry, 40, Queen's-gate, London, S.W.7.

LT.-COL. S. M. LOVELL, O.B.E., T.D., A.M.I.C.E., A.M.I.Mun.E., A.M.T.P.I., County Surveyor of the West Riding of Yorkshire, has been elected President of the Institution of Highway Engineers, 47, Victoria-street, London, S.W.1, in succession to MR. R. B. CARNEGIE, C.B.E., M.I.Mun.E., who has held that office for two years.

MR. W. F. RANDALL, B.Sc. (Lond.), A.R.S.M., M.I.E.E., F.I.M., a director of Telcon, has been appointed managing director of a metals group newly established by the directors of the Telegraph Construction and Maintenance Co. Ltd.

COLONEL H. T. THORNLEY, managing director of J. and H. McLaren Ltd., Leeds, a Brush Group subsidiary company, is relinquishing that position on August 27 to join the staff at Group headquarters in London. He will be director of administration and supply.

MR. C. H. E. RIDPATH, B.Sc., M.I.E.E., A.M.I.Mech.E., chief electrical engineer of the Aluminium Wire and Cable Co. Ltd., since its formation, has been appointed consulting electrical engineer to the company. He will continue to act in this capacity after the normal date of his retirement next April, having completed more than 42 years of continuous service in the aluminium industry. MR. W. J. NICHOLLS, B.Sc., A.C.G.I., M.I.C.E., M.I.E.E., has been appointed chief electrical engineer in succession to Mr. Ridpath.

MR. H. C. GILLVRAY, A.M.I.Mech.E., chief body designer at Leyland Motors Ltd., Leyland, Lancashire, retired on July 15 after 20 years with the company.

MR. N. F. STEVENS, A.M.I.Mech.E., M.I.Loco.E., has been appointed assistant chief mechanical engineer (workshops), East African Railways and Harbours Administration.

MR. C. N. TAYLOR has been appointed director of the Sheffield and District Engineering Trades Employers' Association, in succession to MR. T. GODDARD MANDER, who has retired.

MR. B. B. GREEN, M.C., and MR. W. J. MCBRIDE, A.M.I.Mech.E., have been elected directors of Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield, 9. MR. H. BORROWDALE, chief draughtsman of the firm's trackwork department, has retired after 42 years of service in that department.

MR. G. W. TURTON, M.I.Mech.E., has been appointed general manager of J. H. Humphreys and Sons, Ltd., Oldham, as from August 8.

MR. E. CROME, who has been secretary to Richard Sutcliffe Ltd., Horbury, Wakefield, for the past two years, has been appointed to the board as financial director, while retaining the office of secretary.

MR. J. S. DUMERESQUE, A.M.I.E.E., has been appointed general manager of Semtex Ltd., a subsidiary company of the Dunlop Rubber Co. Ltd.

MR. C. A. BAKER, A.M.I.E.E., who has been in charge of the electric control-gear side of the business of William Geipel Ltd., Vulcan Works, 156-170 Bermondsey-street, London, S.E.1, since 1946, has been appointed a service director of the company.

MR. H. H. HATTON has been appointed assistant manager of the Liverpool branch of the General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2.

MR. A. W. HANSON, until recently manager of the Karachi office of Babcock and Wilcox Ltd., has been appointed to the managership of the firm's Newcastle office. MR. P. R. BETTLE is his deputy.

MR. F. G. ROBB has retired from the position of chief of the Test Division of Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, after 36 years of service. He is succeeded by MR. E. H. EVANS. MR. R. E. BURNETT, M.A. (Oxon.), A.M.I.E.E., A.Inst.P., who has been assistant to the general manager for special duties, as well as manager of education and technical personnel and Principal of Marconi College, has now been appointed full-time assistant to the general manager. MR. E. R. L. LEWIS, M.A., A.M.I.E.E., is to be manager of education and technical personnel, and MR. R. G. HULSE, B.Sc. (Hons.), Principal of Marconi College.

MR. R. D. HUME has been appointed deputy managing director and works director of Foundry Services Ltd., Long Acre, Nechells, Birmingham, 7. MR. R. A. MILLER has been made director with executive duties as sales manager, MR. G. E. COBBY, director with executive duties as chief accountant, DR. D. V. ATTERTON, technical manager, and MR. R. F. BODDEY, deputy technical manager. MR. R. A. MILLER has been appointed director, MR. G. E. COBBY, secretary and MR. D. A. J. PATTERSON, manager, of Foundry Services (Overseas) Ltd.

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COMMERCIAL

YATES PLANT LTD. are removing to Whidborne-street, London, W.C.1 (Telephone: TERminus 0568/9) as from August 15.

EDWARDS HIGH VACUUM LTD., Manor Royal, Crawley, Sussex, in conjunction with Societa Apparecchi Elettrici e Scientifici, have formed an Italian subsidiary company, EDWARDS ALTO VUOTO S.p.A., Milan.

THE SHEFFIELD TWIST DRILL AND STEEL CO. LTD., Summerfield-street, Sheffield, 11, have acquired the whole of the issued share capital of ACCURATE SCREW THREADS LTD., Precision Works, Victoria street, Hednesford, Staffordshire. The managing director, MR. H. MORRIS, retains his seat on the board; the other directors have retired. MR. W. T. BROOKS has joined the company as general manager.

DUNFORD & ELLIOTT (SHEFFIELD) LTD. announce that the department of their company now operating from Linford-street, London, S.W.8, will be formed into a separate subsidiary company as from August 1. The new company will be styled DUNFORD & ELLIOTT PROCESS ENGINEERING LTD. and will handle the firm's rotary louvre dryers, coolers, roasters and other products.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE CO LTD., have acquired the whole of the undertaking of MAGNETIC & ELECTRICAL ALLOYS LTD., Burnbank, Hamilton, Lanarkshire. The latter concern will carry on business as heretofore. MR. J. ANCEL HOLDEN is continuing as chairman and MR. W. F. RANDALL, B.Sc., A.R.S.M., M.I.E.E., F.I.M., a director of Telcon, has been appointed vice-chairman and managing director. The other directors are MR. B. H. MUSGRAVE, a director of Telcon, and MR. A. A. ASPLIN, who will continue as works director at Hamilton.

Jointly owned by the CANADA WIRE AND CABLE CO., LTD., Toronto, the GENERAL CABLE CORPORATION, New York, and the TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. LTD., of Great Britain, a new company, TELECABLES AND WIRES LTD. has been formed to manufacture a complete range of telephone cables and wires, at Fort Garry, Winnipeg, Manitoba. It is proposed that the board of directors of the new company shall comprise MR. J. R. BRADFIELD, MR. L. G. LUMBERS and MR. O. W. TITUS of the Canada Wire and Cable Co., MR. I. T. BENNETT and MR. J. R. MACDONALD of the General Cable Corporation and MR. J. N. DEAN of the Telegraph Construction and Maintenance Co.

BRITISH TYRE & RUBBER CO. LTD. announce a further extension to the B.T.R. mobile conveyor-belt service for the splicing of conveyor belting on site and also for belting repairs. Inquiries should be made to one of the three sales branches, namely: Herga House, Vincent-square, London, S.W.1 (Telephone: TATe Gallery 8361); Broughton Bridge, Blackfriars-road, Manchester, 3 (Telephone: Blackfriars 7803); and 26 Kingston-street, Glasgow, C.5 (Telephone: South 2782).

CHARLES CHURCHILL AND CO. LTD., South Yardley, Birmingham, 25, have formed a subsidiary company —Churchill-Sturm Ltd., 27 Walnut Tree-walk, London, S.E.11—to manufacture the Sturm variable-speed hydraulic drive. This unit, which has been in production in Germany for some 20 years, will be known as the Churchill-Sturm hydraulic drive.

CONTRACTS

Fighter-Bomber Aircraft. An order for a quantity of Venom Mk. 4 aircraft for the Venezuelan Air Force has been received by the DE HAVILLAND Aircraft and Engine Companies, Hatfield, Hertfordshire. The Venom Mk. 4 is a single-seat fighter-bomber powered by the firm's Ghost engine.

Airfield Control Radar. The Director-General of Civil Aviation, India, has awarded DECCA RADAR LTD., 1-3 Brixton-road, London, S.W.9, a contract for the installation of airfield control radar, type 424, at Dum Dum Airport, Calcutta. This equipment is to be used as an approach aid at this airport and is expected to be in operation by the autumn.

Communication Equipment in Steelworks. Four further important orders for the firm's "Clear-call" industrial communication equipment—all for steelworks—have been obtained by the BRITISH THOMSON-HOUSTON CO. LTD., Rugby. The first, a repeat order, comes from the Steel Co. of Wales Ltd., and is for carrier-frequency equipment for providing communication between personnel at four ore transporters, hatchways, stockyards and the foreman's office. Several frequencies will be employed so that a number of conversations can take place at the same time. Another interesting feature is that the carrier frequency signal is injected into or imposed on a 3·3-kV power supply. The same company has placed a second order for equipment for two-way communication between the ground and overhead cranes. The third order is for equipment to provide communication in a large ore-handling plant under construction at the Guest, Keen Iron and Steel Works, Cardiff. The fourth order, another repeat, is for John Lysaght's Scunthorpe Works and is for two-way communication equipment between ground points and soaking-pit cranes.

Radio Telephone and Telegraph Centre. An order valued at more than £125,000 has been placed by the Government of Burma with STANDARD TELEPHONES AND CABLES LTD., Connaught House, Aldwych, London, W.C.2, to equip a new overseas radio telephone and telegraph centre. New radio stations at Rangoon will provide Burma with a direct public radio telephone circuit to London, and radio telephone and telegraph circuits to Madras in India. The order includes DS.13 and DS.12 single-sideband transmitters of 40 kW and 4 kW power, respectively, RX9A single-sideband receivers, RX5B radio telegraph receivers, terminal and privacy equipment, teleprinters and beam aerials.

Diesel Engines for Tractors. An initial order for 1,000 four-cylinder L4 Diesel engines for a new medium Australian tractor has been placed with F. PERKINS LTD., Peterborough. The engine will develop 57 b.h.p. at 2,000 r.p.m., and the maximum drawbar horsepower of the tractor will be 42 at 1,600 r.p.m. The tractor, of four-wheel type, is being manufactured by CHAMBERLAIN INDUSTRIES PTY. LTD., Perth, and the immediate programme envisages the production of 1,000 tractors before the end of June, 1956. It is hoped that eventually the tractors will be produced at a rate of 3,000 a year.

Television and Sound Broadcasting Station. The British Broadcasting Corporation has placed a contract for the building work at the Blaen Plwy, Cardiganshire, television and very-high-frequency sound broadcasting station with E. T. DAVIES & SON, Felindre Mills, Aberarth, Aberavon, Cardiganshire. The contract covers the construction of the transmitting-station building, the installation of the water-supply and drainage and the provision of access and service roads and fencing. It is hoped to bring the station into service towards the end of 1956.

Railway Signalling Equipment. The supply and installation of signalling equipment for the new hump yard at Temple Mills railway marshalling yards, Eastern Region, has been entrusted to the WESTINGHOUSE BRAKE AND SIGNAL CO. LTD., 82 York-way, King's Cross London, N.1.

Dumping Machines. The Department of Defence of the Pakistan Government has placed an order for sixteen 3-cub. yd. Muir-Hill dumpers with E. BOYDELL & CO. LTD., Old Trafford, Manchester.

Railway Wagons. The British Transport Commission announces that contracts have been placed for 319 twenty-ton ballast and sleeper wagons. THE DERBYSHIRE CARRIAGE AND WAGON CO. LTD., Chesterfield, is to build 100 wagons, the CAMBRIAN WAGON AND ENGINEERING CO. LTD., Maindy, Cardiff, 169 wagons, and the GLOUCESTER RAILWAY CARRIAGE AND WAGON CO. LTD., Gloucester, 50 wagons.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Survey of Life-Saving Appliances: Instructions to Surveyors. Ministry of Transport and Civil Aviation. Merchant Shipping. *H.M. Stationery Office, Kingsway, London, W.C.*2. (6*s.*)

These instructions to marine surveyors explain in detail how the Merchant Shipping (Life-Saving Appliances) Rules, 1952, are applied. This edition supersedes an earlier publication entitled *Instruction as to the Survey of Life-Saving Appliances.*

Materials of Construction: Their Manufacture and Properties. By ADELBERT P. MILLS. Sixth edition rewritten and edited by LLOYD F. RADER. *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (7·50 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (60*s.*)

The first edition appeared in 1915 as a text-book written from lectures at Cornell University. In the sixth edition, material has been added on the subjects of mixed aggregates, structural clay products and organic coatings and plastics. The chapters on metallography constitution of metals, and fatigue have also been enlarged and brought up to date.

The Testing and Inspection of Engineering Materials. By HARMER E. DAVIS, GEORGE EARL TROXELL and CLEMENT T. WISKOCIL. Second edition. *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (6·50 dols.); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (49*s.*)

The first part of this text-book deals with the principles of testing and inspection. It includes: general features; tensile, compressive and hardness tests; bending tests; and presentation of data. The second part is a summary of laboratory duties and 24 problem tests for students. The volume concludes with some appendices giving properties of various materials.

Engineering Inspection. An Introduction to Inspection Work Including Special Reference to Aero Requirements. By A. C. PARKINSON. Third edition. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.*2. (10*s.*)

Like the first edition which appeared in 1940, this volume is intended to cover a wide field on elementary lines. The third edition has been amended to conform to revised British Standards.

Magnetic Control of Industrial Motors. By GERHART W. HEUMANN. Second edition. *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (10·75 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (86*s.*)

This book is one of a series written in connection with the American General Electric Company's advanced engineering programme. The second edition has been brought up to date to include the revised standards. All types of motor starter and controller are dealt with, and each chapter concludes with a set of problems.

Transistor Audio Amplifiers. By RICHARD F. SHEA. *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (6·50 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (52*s.*)

The author is in charge of research liaison at the General Electric Company's laboratories at Syracuse, U.S.A. The primary purpose of his book is to provide practical fundamentals of transistor application in the construction of audio amplifiers. The treatment has been kept general, and conversion tables are given for alternative representations. There are sections on hearing aids and pre-amplifiers.

Safety and Health in Industry. *Sky Press, Limited, Porteus House, Porteus-road, London, W.*2. (Free on application.)

The purposes of a buyers' guide and a handbook on safety in industry are combined in this volume. Methods of avoiding industrial injuries are described and illustrated, and suppliers of safety equipment and clothing are named. Hints on protection of feet, hands, eyes and skin are given and also notes on general factory safety precautions.

Magnetic Amplifiers. By H. F. STORM. *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (13·50 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (108*s.*)

Dealing mainly with single-phase amplifiers, this book is written at American graduate level and is one of the General Electric Company's series for the advancement of engineering knowledge. Ten authors have contributed. The theory is presented together with much practical information on materials and techniques. Dr. Storm is magnetic amplifier specialist at the Schenectady laboratories of the General Electric Company.

A Shock-Tube Investigation of Detonative Combustion. By RICHARD BOYD MORRISON. Michigan University Press. *Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.*4. (26*s.*)

After giving the theory of detonative processes, steady and unsteady flows are analysed and the connection between shock waves and detonation waves discussed. A dimensionless heating parameter is described. The experimental equipment to produce the waves is described and results given. References and a bibliography are included.

Shell Moulding. Part 2. "Machinery's" Yellow Back Series No. 34A. *The Machinery Publishing Company, Limited, National House, West-street, Brighton,* 1. (4*s.*)

This is a "follow-up" of part 1 and describes new moulding machines, both hand and automatic, and new techniques that have been introduced. Methods of casting stainless steels, magnesium, and non-ferrous alloys are given, together with methods of clamping, backing-up and chilling the moulds.

British Chemicals and their Manufacturers, 1955. *Association of British Chemical Manufacturers, Cecil Chambers,* 86 *Strand, London, W.C.*2. (Free to the trade.)

This book is published bi-annually with a view to giving purchasers of chemicals information on the products made by members of the Association. The contents include a directory of members, a classified list of British chemicals, indicators and microscopical stains, with their manufacturers, and lists of trade names and trade marks. All products are named systematically in accordance with British Standard 2474-1954.

Model Mechanical Engineering. By ERNEST A. STEEL. *Cassell and Company, Limited,* 37/38 *St. Andrew's-hill, London, E.C.*4. (18*s.*)

The first part of the book describes the amateur's workshop, its tools and equipment. A large section is devoted to workshop practice. Subsequent sections describe boilers, steam engines, traction engines, locomotives and internal-combustion engines. The author was a colleague of the late Henry Greenly.

The following reports are obtainable from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey:—

The Measurement of Power Loss at Temperatures up to 100 deg. C. and Frequencies up to 100 Mc/s. By E. RUSHTON and G. RUSSELL. No. L/T282. (7*s.* 6*d.*) Dielectric measurements on solid insulating materials over the frequency range 10 kc/s to 100 Mc/s using modified Hartshorn-Ward equipment with heating elements in the copper plates.

The Dielectric Properties of Acenaphthylene Styrene Copolymers. By J. V. L. PARRY. No. L/T286. (3*s.*) This material is of interest as the softening point is higher than that of polystyrene.

Further Improvements to the Vacuum Torsion Balance and Sorption Measurements on Polystyrene. By A. G. DAY. No. L/T292. (10*s.* 6*d.*) The methods of improvement are described. Sorption measurements have been repeated and diffusion coefficients calculated. These are 1,000 times smaller than those obtained from Thomas and Gents' figures, indicating that Fick's law does not fully explain the process.

Growing of Perovskite-Type Crystals. By H. F. KAY and J. L. MILES. No. L/T303. (7*s.* 6*d.*) Although most of the results of the preparatory examination and inquiry are negative, they are recorded to provide pointers for subsequent efforts. Results of other workers are included.

Breakdown of Solid Dielectrics in Divergent Fields. By J. H. MASON. No. L/T310. (21*s.*) Tests were carried out with needle-points embedded in polythene and polyisobutylene. About 25 per cent. greater stress was required for negative than for positive points. Factors affecting the industrial electric strength are discussed and illustrated by tests on polythene, polystyrene and cellulose acetate.

Artificial Lighting for Plant Growth. By A. E. CANHAM. No. W/T31. (1*s.* 6*d.*) This report appeared in the Transactions of the Illuminating Engineering Society, vol. XIX, no. 8. It describes experiments carried out on different plants, such as tomatoes and chrysanthemums, both for forcing and retarding them. The efficacy of different light sources is discussed.

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BRITISH STANDARDS

*The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2 Park-street, London, W.*1, *at the price given after each title.*

Electrical Performance of Rotating Electrical Machinery. (7*s.* 6*d.*, post free.)

The four principal standards relating to the electrical performance of rotating electrical machinery, namely, B.S.168:1936; 169:1925; 225:1925 and 226:1925 have been revised and combined into a single new publication, B.S.2613:1955, which covers all types of electric motors and generators rated from 1 h.p. per 1,000 r.p.m., or 0·75 kW or kVA per 1,000 r.p.m., upwards.

To conform to present-day practice, a number of significant changes have been made, the most important of which is the recognition of the continuous maximum rating for all motors, whether A.C. or D.C., which exceed 50 h.p. per 1,000 r.p.m. Open, protected and pipe- or duct-ventilated motors, which are rated at not more than 50 h.p. per 1,000 r.p.m., continue to be specified on a load-with-overload basis, but attention is drawn to the fact that this feature will disappear with the next revision, which will coincide with the introduction of a revised classification of insulating materials.

The tables containing details of permissible temperature rise have been completely re-cast, and for each type of winding, a method of temperature measurement is now specified.

Radiographic Examination of Fusion-Welded Joints (in thicknesses of steel up to 2 in., with general recommendations). (4*s.*, post free.)

The work resulting in the general recommendations for the radiographic examination of fusion-welded joints, contained in the new British Standard 2600, has been undertaken at the request of the British Welding Research Association.

The publication is divided into four sections, the first of which deals with general recommendations for all types of radiography coming within the scope of the standard. The second section relates to X-ray techniques for general application and the third to X-ray techniques for special applications. The fourth section is concerned with gamma-ray techniques. An appendix which amplifies the statements made in the various clauses and contains explanatory notes is included.

Rotary Drill Rods and Rotary Drill Bits (tungsten-carbide tipped, for dry drilling). (2*s.* 6*d.*, post free.)

A new British Standard, B.S.2593, covering rotary drill rods and tungsten-carbide tipped rotary drill bits for dry drilling has now been issued. It forms one of a series which it is intended to prepare for the mining and quarrying industries where cutting and drilling equipment common to both is in use. The present standard specifies the requirements for the shank of the drill rod, the size and position of the slot into which the bit is fitted and a tolerance for rod straightness. The sizes for shank and depth of shoulder are given for seven diameters of bit. The specification is intended to provide interchangeability between the drill rod, the drill-spindle socket and the bits. Another object is to reduce as far as is consistent with efficiency, the number of different types at present in use. In view of developments now taking place, detailed requirements for materials have been omitted.

Zinc-Alloy Pressure Die Casting for Engineering (British Standard Code of Practice). (5*s.*, post free.)

Code of Practice C.P.3001 has been prepared by a joint committee of the Institution of Mechanical Engineers and the British Standards Institution, and is based on proposals submitted by the Zinc Alloy Die Casters' Association. It has as its objective the establishment of recognised practices in the design, production and inspection of zinc-alloy die castings in order to ensure that the materials used, the procedures followed, and the design of the castings shall provide a product that is reliable in every respect. Zinc-alloy die castings will perform satisfactorily in service only if they are free from contamination by certain elements harmful to their mechanical properties and corrosion resistance. It is emphasised, therefore, that it is essential that these elements, and, in particular, lead, tin and cadmium, should not be present in higher proportions than those indicated in B.S.1004, which covers zinc alloys for die casting.

SAVING TIME IN THE DRAWING OFFICE

PREPARATION OF PLANT LAYOUTS

By F. E. Guest

The layout of large modern power plant with its increasing complexity calls for a high standard of technical skill in the drawing office. Owing to the limited number of men of the right calibre available it has become necessary to consider every possible way of using such men in the most efficient manner. The purpose of this article is to make known the availability of a process which the writer has found solves the main problem and which, with the co-operation of Messrs. E. N. Mason and Sons, Limited, of Colchester and Manchester, he has developed and established as standard practice in his own sphere of activity, i.e., the design and layout of power stations.

The methods proposed to reduce work in the drawing office described in an American book published two years ago* no doubt have their application in certain offices, although it may be said that none of these is really new as most of them have already been tried and a number of them practised in this country. The technique described here is in principle not new but its particular application and development for the preparation of plant layout drawings are believed to be.

Normal drawing office procedure when preparing a drawing showing the layout of plant is as follows:—

(1) A suitable scale is determined.
(2) The limits of enclosure (walls, steelwork, etc.) are set down.
(3) The position of plant is determined and locating centre-lines drawn.
(4) The outlines of the various items of plant or equipment are obtained from the dimensioned drawings supplied by the plant or equipment manufacturer and are drawn in to the chosen scale.
(5) Interconnecting pipe-work and valves, cables, etc., are drawn in and the layout completed.

The work referred to under item (4) occupies a very large proportion of the draughtsman's time, particularly if several possible layouts have to be prepared, and it is to obviate the necessity of his re-drafting items of plant already accurately drawn by the manufacturer (and bearing in mind the essential features required, i.e., the drawing must be accurate to scale, show general clearances and access for maintenance purposes) that the following procedure has been developed:—

(1) A suitable scale is determined, as before.
(2) The limits of enclosure (walls, steelwork etc.) are set down, as before.
(3) The position of plant is determined and locating centre-lines drawn, as before. A typical drawing at this stage is shown in Fig. 1.
(4) A good clear outline drawing (either in pencil or ink) of each item of plant or equipment is obtained from each manufacturer and sent to Messrs. E. N. Mason and Sons, Limited, who can provide reproductions in the form of fine black lines on thin transparent film to the scale required. These " transparencies " are coated on the underside with a dry adhesive and protected with a removeable tissue. The scale used on the original drawing does not matter but it is essential that plant centre-lines are indicated. Any number of transparencies can be obtained to any stated scale and at a reasonable cost. The process of application is made simple as the transparencies can be located on the drawing by means of their centre-lines and fixed by means

* *Simplified Drafting Practice* By W. L. Healy and A. H. Rau. John Wiley, New York, and Chapman and Hall, London. Reviewed in ENGINEERING, vol. 176, page 625 (1953).

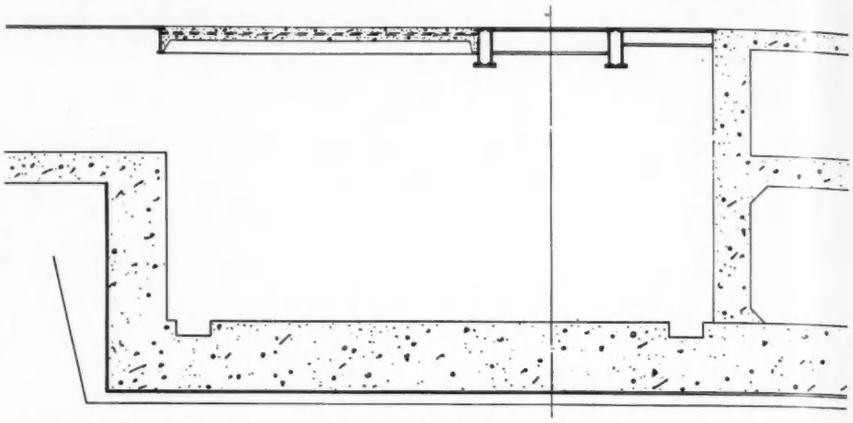

Fig. 1 Showing the first stage in preparing a typical layout drawing. This stage is done by hand in the normal way.

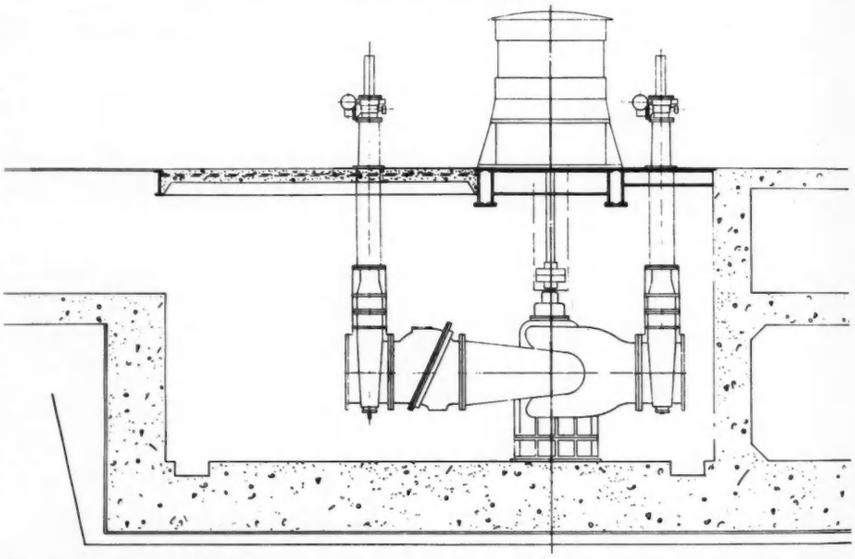

Fig. 2 The second stage takes only a few minutes. Standard components (in this case a motor, pump, valves, etc.) are not drawn by hand; instead, pre-printed transparencies of them are fixed to the drawing. (The transparency is revealed in Fig. 4.)

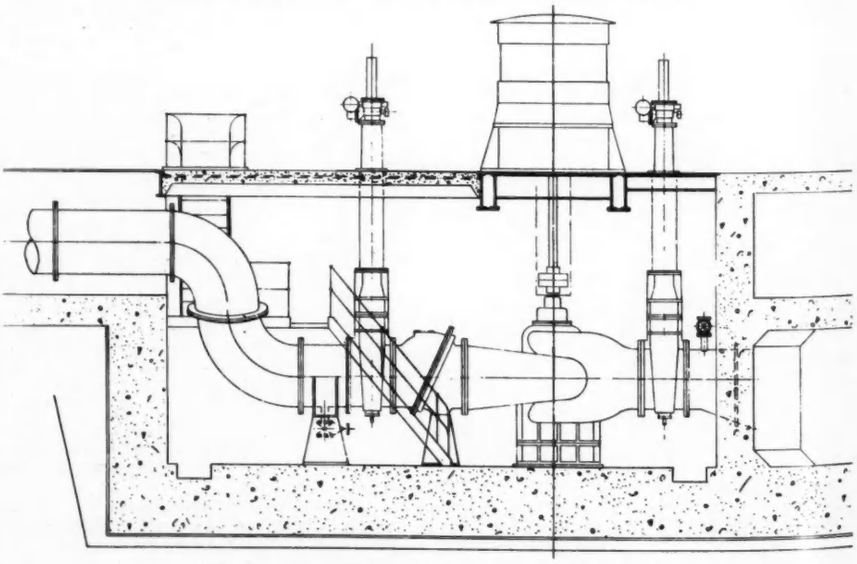

Fig. 3 The remaining details are completed by hand.

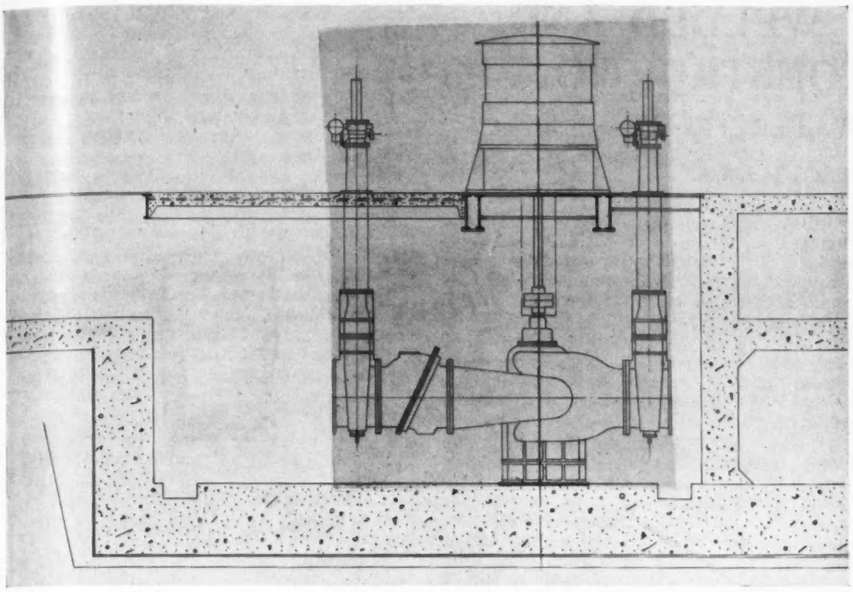

Fig. 4 This illustration shows the use of the transparency which saves time in preparing plant layout drawings. It shows the same stage as Fig. 2, but being reproduced from a photograph it reveals the position and extent of the transparency.

of a little pressure plus warmth from the hand. The drawing at this stage is shown in Fig. 2, and also in Fig. 4, which, being reproduced from a photograph of it, reveals the " transparency."

Before proceeding to complete the drawing as under item (5) the drawing can be run through the photo-copying machine, where the warmth from the lamp and the pressure applied will give a permanent adhesion. A still better method is to place the drawing on the surface of a flat bed dryer. This is an electrically-heated plate where the pressure from the canvas overlay (obtained by pressing a lever) results in excellent adhesion.

(5) As before. Fig. 3 shows the completed drawing.

It will be seen that with the use of these true-to-scale transparencies alternative arrangements of plant are easily and quickly obtained. The method has many other advantages in addition to time-saving, particularly as the manufacturer usually includes more on his drawing than is necessary for the purpose of determining plant layout. Two typical instances illustrating the value of this feature actually encountered in practice are given hereunder:—

(*a*) A plant contractor sent in a drawing showing the proposed location of a main steam stop-valve in relation to boiler access. The valve and its operation were shown in the usual symbolic form of a "cross with a flagpole." Normally it would have been necessary to draw the valve outline correctly and to scale to determine the actual clearance between the valve, its operating gear and adjacent steelwork, but having available the valve makers' drawing in the form of a transparency, and to the same scale as the plant contractor's drawing, all that was necessary was to fix this to the drawing, which was then returned to the contractor to indicate how the valve body fouled his gallery.

(*b*) The transparency taken from a drawing of a high-pressure steam strainer indicated in plan the lid holding-down studs, which are not normally drawn in by the plant layout draughtsman. This was a useful reminder in a very congested pipework arrangement that clearance must be provided to enable the valve lid to be removed.

The above are simple illustrations of the many ways in which the true-to-scale transparencies can be used.

It is to be noted that if the completed drawing is filmed and reproduced by either the "Statfile" or "Barcro" process, the result will appear as good as if the drawing had been made in the normal way (as in Fig. 3). It is possible to take dyeline prints direct from the original drawing, but in this case the area covered by the transparencies will appear (as in Fig. 4), though it will not affect the legibility of the drawing. Where, as is usual in the case of modern power stations, a number of alternative arrangements with units of similar outlines have to be prepared before a final layout is made, time-saving can be phenomenal.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Steam Power Plant. SIMON-CARVES, LTD., Cheadle Heath, Stockport. The principles of Simon-Carves water-tube boilers and features of power station design; boiler development, including use of pulverised fuel, twin-circulation system, water-wall combustion chambers, superheaters, methods of boiler firing and materials of construction; principle and operation of "once-through" forced-circulation boilers; boiler ancillary plant, including economisers, air heaters, head-water treatment, electro-precipitators, handling of grit and dust, ash, and coal and coke; detailed descriptions with drawings and illustrations of some Simon-Carves contracts. Elaborately illustrated and produced book.

Fractional Geared Motors. ELECTROPOWER GEARS, LTD., Kingsbury Works, Kingsbury-road, London, N.W.9. Fractional geared motors and speed reducers with coaxial shafts; types ESR50 and ESRV50 with maximum torque of 24·6 ft. lb. at 12 r.p.m.; maximum and minimum standard ratios 116·8 : 1 and 2·56 : 1. Illustrated leaflet with dimensions, horse-powers and torques.

Switches and Signal Lamps. ARCOLECTRIC (SWITCHES) LTD., Central-avenue, West Molesey, Surrey. Toggle, push button, slide thumb, and switches for automobile applications; mains and low-voltage signal lamps. Illustrated catalogue No. 129 contains ten new products and alterations to existing designs.

Non-Ferrous Metal Products. IMPERIAL CHEMICAL INDUSTRIES, LTD., Millbank, London, S.W.1. Non-ferrous metal products for the petroleum industry including copper, aluminium, titanium, and their alloys in sheet, strip, rod, section, wire, tube and plate; also lead plate, sheet and pipe. Illustrated booklet with examples of applications.

Electrostatic Air Cleaner. STURTEVANT ENGINEERING CO., LTD., Southern House, Cannon-street, London, E.C.4. "Precipitron" electrostatic air cleaner with fine-wire ionising electrodes and plate connectors; cleaning by washing; safety devices to prevent access when charged. Illustrated leaflet.

Insulation Materials. NEWALLS INSULATION CO., LTD., Washington, Co. Durham. Materials and methods for heat and sound insulation; problems of noise and acoustic treatment; sprayed limpet asbestos, properties and applications; insulating bricks, properties and applications. Four illustrated booklets.

Tubular Heat Exchangers. WELLINGTON TUBE WORKS, LTD., Great Bridge, Tipton, Staffordshire. "Weldex" tubular heat exchangers with fixed or removable tube bundles. Publication No. 155 gives description of types available and details of mechanical design.

Multi-Range Test Set. MEASURING INSTRUMENTS (PULLIN), LTD., Electron Works, Winchester-street, London, W.3. Instrument for measuring d.c. and a.c. voltage and current, and two ranges of resistance, 0 to 1 megohm and 0 to 10,000 ohms. Illustrated leaflet (Section D, Leaflet 100).

Moulded Plastics. GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2. Moulded plastics for industry, describing what jobs they can do; production of a plastics moulding is described from design to completion. Illustrated booklet.

Aluminium Alloys for Shipbuilding. NORTHERN ALUMINIUM CO., LTD., Banbury, Oxfordshire. "Noral" plate, sheet and sections for shipbuilding giving properties, limits and tolerances. Illustrated booklet, intended only as short guide to materials available.

Castellated Construction. UNITED STEEL STRUCTURAL CO., LTD., Frodingham Works, Scunthorpe, Lincs. Manufacture and uses of "Castella" beams. Tables of section values and properties. Notes on current research work. Examples of completed structures. Illustrated booklet.

Building Components. THE MODULAR SOCIETY, LTD., 22 Buckingham-street, London, W.C.2. Third issue of catalogue sheets: No. 8 (revised) Partition Blocks; No. 14, Steel Framework; No. 15, Precast Concrete Flooring Units; and No. 16, Lighting Equipment.

Pallet Truck. J. COLLIS & SONS, LTD., Regent-square, Gray's Inn-road, London, W.C.1. Hydraulic- and assisted-leverage trucks for handling pallet loads. Three- and four-wheel models for loads up to 7 tons. Illustrated booklet.

Blowers. W. C. HOLMES & CO., LTD., Turnbridge, Huddersfield. Holmes-Connersville blowers; capacities up to 200 cub. ft. per min. at 7 lb. per sq. in. Pamphlet gives general and detail descriptions.

Immersion Heat Exchanger. Q.V.F., LTD., Mill-street, Stone, Staffordshire. Heat exchanger for use in chemical laboratories, flask sizes 50, 100 and 200 litres; also suitable for use as steam heater. Illustrated leaflet.

Filters and Strainers. INTERMIT LTD., 37 Bradford-street, Birmingham, 5. Wire-woven, cloth and perforated metal filters and strainers of many designs. Catalogue gives full details and technical information on the materials used.

Steel Office Equipment. G. SAVITT & SONS, LTD., 20 Brewer-street, London, W.1. "Howden" and Vickers-Armstrongs steel office equipment. Filing and storage cabinets, desks and chairs. Catalogue and price list No. 150.

Molybdenum Disulphide. ACHESON COLLOIDS, LTD., 18 Pall Mall, London, S.W.1. Properties and lubrication uses of colloidal molybdenum disulphide. Leaflet.

Spray Painting. DRUMMOND PATENTS, LTD., 5 Great Winchester-street, London Wall, London, E.C.2. Spray painting with washer filtration using patented spray booths. Illustrated leaflet gives brief details.

Ring-Main Switch. A. REYROLLE & CO. LTD., Hebburn, Co. Durham. Type JKSS oil-immersed ring-main switch and T-off fuse-switch unit for service up to 11 kV. Leaflet 1281.

Flexible Couplings. WHITTAKER, HALL & CO. (1929) LTD., Black-lane Works, Radcliffe, Manchester. Flexible rubber couplings for powers from 0·15 to 150 h.p. at 100 r.p.m. Leaflet.

Hollow-Cathode Lamps. HILGER AND WATTS LTD., 98 St. Pancras-way, London, N.W.1. Sealed hollow-cathode lamps for the study of hyperfine structure. Descriptive leaflet.

Low-Lift Platform Truck. YALE AND TOWNE MANUFACTURING CO., Wednesfield, Wolverhampton. Electric "Stubby" platform trucks, 2 and 3 tons capacity. Platform lift 4 in. Bulletin B1206.

COMPARISON OF WELDED AND RIVETED SHIP CONSTRUCTION

SEA AND STILL WATER TRIALS

By B. Baxter, M.SC., M.I.N.A.

In the early part of 1943, and while the Admiralty were increasingly encouraging the use of welding in the construction of ships being built in British shipyards, reports of failures in welded ships built in the United States were being received. The most outstanding and startling was the case of the all-welded tanker Schenectady which, for no apparent reason, broke in two on January 16, 1943, while tied alongside a quay at Portland, Oregon. Although we had had no similar troubles it was clear that if United States welded ships had failed, British welded ships might fail also and the subject therefore demanded close consideration.

In June, 1943, at the instigation of the First Lord of the Admiralty, the Admiralty Ship Welding Committee was set up with terms of reference as follows: "To consider and investigate special problems arising from the employment of welding in ships' structures and to advise on methods for their solution." A working committee known as the Admiralty Ship Welding Sub-Committee was also appointed and included on this were representatives of Admiralty departments, Classification Societies, the Welding Research Council and later the British Shipbuilding Research Association.

One of the main investigations carried out by the Committee and Sub-Committee was to find the relationship, if any, between welded ship failures and design, with particular reference to the differences in structural behaviour between riveted and welded ships. It had been established that the scantlings of all the welded ships in which structural casualties had occurred did, in fact, comply with the Classification Society requirements for riveted ships, and that no scantling reduction had been made because welding had been used.

Because quantitative knowledge on the structural behaviour of riveted ships was scanty, the problem of finding the differences between riveted and welded ships could only be tackled by the use of fundamental principles. New methods and instruments had to be developed which would accurately enable stress distributions under service conditions to be found, and existing theories had to be examined critically in order to ascertain their suitability as a basis for comparison.

Statical strength experiments on such ships as the Empire Duke, Neverita and Newcombia provided very useful information, but after a preliminary test on the tanker Niso at sea it became clear that a great deal still remained to be learnt about the behaviour of a ship's structure under dynamic conditions.

PROGRAMME OF STRUCTURAL TESTS

In comparing the structural behaviour of riveted and welded ships at sea it at first appeared practical to send to sea ships of similar form and structural design, one being riveted and the other welded, and to measure the stresses on each simultaneously. On close examination, however, this proposal presented serious difficulties. No matter how closely the two ships sailed together they would be unlikely to encounter the same wave conditions. During rough weather, when the results would be of maximum importance, the discrepancies would be greater as the distance between the vessels would have of necessity to be increased. After very careful consideration, therefore, the Committee decided to proceed as follows :—

(1) The Ocean Vulcan, a 10,000-ton deadweight all-welded standard dry-cargo ship built in the United States to the order of the Admiralty, was to engage in its normal trading on the North Atlantic route for at least twelve months. During this period a very complete record would be kept of the various types of forces, weather conditions, wave particulars, frequency of stress occurrences, etc., to which the ship was subjected.

(2) The Ocean Vulcan was to be subjected in still water to all the different types of forces likely to be met with at sea. These forces would include bending, shearing, and torsion. The corresponding stresses and deflections produced would be measured.

(3) The Clan Alpine, an all-riveted ship closely similar to the Ocean Vulcan, would be subjected in still water to the same forces as the Ocean Vulcan in still water. The results of the trials in still water on both ships would then be applied to the probable maximum loads as derived from the sea trials in order to estimate the maximum stresses at sea for both the riveted and welded ships.

This procedure was adopted and the results of the various trials have been published by H.M. Stationery Office for the Admiralty Ship Welding Committee with the Authority of the Lords Commissioners of the Admiralty. The reports relating to the trials are:—

R.6 Ocean Vulcan. Still Water Experiments.
R.7 Clan Alpine. Still Water Experiments.
R.8 Ocean Vulcan. Sea Trials.
R.9/10/11 Ocean Vulcan. Sea Trials. Detailed Analyses.
R.12 Ocean Vulcan and Clan Alpine Structural trials. Discussion of Results.

The dimensions of the two remarkably similar vessels are:—

Length overall, 441 ft. 6 in., Ocean Vulcan and Clan Alpine.

Length between perpendiculars, 416 ft. 0 in. Ocean Vulcan and Clan Alpine.

Depth Moulded, 37 ft. 4 in., Ocean Vulcan and Clan Alpine.

Beam Moulded, 56 ft. 10¾ in., Ocean Vulcan; 56 ft. 11¾ in., Clan Alpine.

OCEAN VULCAN SEA TRIALS

The Ocean Vulcan sea trials commenced on December 29, 1945, and lasted through eight round voyages until May 19, 1947. During all this time records were taken by gauges fitted on the outside of the hull around twelve transverse sections, and these measured water pressures and wave profiles.

Other readings taken included:—

1. Accelerations of the ship.
2. Wind forces on exposed hull.
3. Angles of roll, pitch and yaw.
4. Engine speed and shaft torque.
5. Ship speed.
6. Longitudinal stresses near amidships.

All the instruments and gauges were connected to one central control room having the indicators and meters mounted on one large panel. This panel was photographed twice every second with a special camera.

Additional measurements included:—

7. Stereoscopic photographs of waves.
8. A statistical strain gauge.

This combined information was sufficient to obtain values for the probable maxima of the various types of loading forces such as shearing and bending in both the vertical and horizontal planes, twisting and transverse bending, and the combinations in which they occurred.

STILL WATER TRIALS

The primary object of the static trials which took place during 1946, 1947 and 1948, was to study the stresses set up on a section near amidships by known changes in the applied bending moments, and also to measure the deflections of the main hull due to these changes. The tests were so planned that each of the following actions could be isolated:—

(*a*) Vertical longitudinal bending moment.
(*b*) Vertical longitudinal shear force.
(*c*) Horizontal longitudinal bending moment and shear force.
(*d*) Torsion moment.
(*e*) Longitudinal compressive action.
(*f*) Transverse bending due to change in draught.

Secondary aims were to measure local stresses and unfairness of plating.

The changes in the bending moments were caused by flooding the water ballast tanks and holds to predetermined depths.

The gauges used to measure the strains were:—

(1) Electric resistance strain gauges, less than 1 in. base length.

During the static trials on the Neverita and Newcombia the electric resistance strain gauge readings were not used in the final analysis because of zero drift errors. In the present experiments, however, the difficulties had been overcome, and no drift was apparent over a period of several weeks.

(2) Building Research Station acoustic gauges, 3¾ in. base length.

(3) Maihak acoustic gauges, 5 cm. and 10 cm. base length.

These gauges were of the same type as those used in the static trials on the destroyer Albuera (I.N.A.* 1952).

(4) Long base gauges, 100 in. base length.

A theodolite capable of reading to 1 second of arc was used to measure the deflection of the ship by observing the movements of fixed targets spaced along the upper deck. Such a theodolite would be capable of reading a movement of approximately 0·01 in. at a distance of 200 ft.

Fifty copper-eureka thermocouples, capable of reading a difference of 1 deg. F. were used to show temperature variations during the trials.

GENERAL CONCLUSIONS

The investigation found that the differences in structural behaviour between the riveted and welded ships are of a secondary character and are related to details of design rather than to overall structural performance. This general conclusion confirms the results of the earlier experiments carried out in 1944 and 1945 on the similar tankers Neverita (I.N.A. 1946) and Newcombia (N.E.C.I.† 1946).

The conception, execution and presentation of the work contained in the Reports forming the Series R.6 to R.12 is on a very high plane. Nothing very revolutionary has been discovered as a result of these trials, and in fact the answers to many problems were suspected before the problems were tackled. However, throughout these trials every possible aspect, practical or theoretical, has been considered and the conclusions are based firmly and confidently on the latest available theoretical considerations and refinements. Where approximations have been made the assumptions justifying the step have been shown and commented on. Anticipating that future workers and theoreticians will either be aided by new theories, or will use a different approach to the problem, the Report very wisely includes, wherever practicable, the actual measurements taken.

The mass of experimental work and the arduous computation involved was prodigious, and the various analyses were so planned that the necessary arithmetical operations could be performed by intelligent, but non-technical, staff. All who have had the opportunity of guiding or contributing to this fine piece of work, rightly deserve the thanks of naval architects and engineers for their solution to a difficult and complicated problem. The conclusions at the

* Transactions of the Institution of Naval Architects.

† Transactions of the North East Coast Institution of Engineers and Shipbuilders.

end of Report R.12, and given below, contain much of interest and importance, and are worthy of close examination, particularly with regard to the sea trials where much new statistical information has been made available.

(1) " Provided due allowance is made for the effects of stress concentrations, local bending and the inefficiencies of panels of plating due to unfairness, the distribution of longitudinal stresses was similar in the two ships examined, and in fair agreement with simple beam theory."

The efficiency (η) of any piece of plating is defined here as the actual heart of plate strain divided by the frame strain. Neglecting the transverse stress the heart of plate stress in the longitudinal direction is η times the stress which would occur at the same point in a plate with 100 per cent. efficiency, i.e., one in which there was no distortion out of the plane. Similarly, the contribution of any piece of plate of cross section A towards the overall moment of inertia is reduced to ηA. The efficiency in some cases was found to be low, and in the second deck of the Ocean Vulcan efficiencies as low as 20 per cent. were observed. The net effect of reduced plate efficiency was to reduce the effective moment of inertia by about 10 per cent.

In static trials on the U.S.S. Philip Schuyler (A.S.N.A.* 1947) the 'tween deck and tank top plating were found to be only 50 per cent. efficient. Accounting for this reduced the moment of inertia of the section by 5 per cent.

Clearly, the stress as forecast using the simple beam theory:—$f = \frac{M\,y}{I}$ can only be used for panels of plating whose efficiency is 100 per cent. In consequence, for all points at which the buckling of the plating is prevented by longitudinal stiffening, the stresses will be higher than those given by the simple theory.

The stress observations made suggest that the application of Lockwood Taylor's theory of shear lag (N.E.C.I. 1924) is complicated in the case of a dry cargo ship by the presence of large deck openings.

(2) " No evidence was found to indicate that the presence of riveted seams affects the general distribution of longitudinal stress."

(3) " Concentrations up to about three times the nominal stress were found at structural discontinuities, with a tendency for the concentrations to be slightly greater in the welded than in the riveted ship."

This concentration of stress has been noted in many previous trials (A.S.N.A. 1949), e.g.:—

	Stress factor
Neverita. Bulwark rails and small hatchways	1·25–1·6
Newcombia. After end of bridge ..	2·0
" Around hatchways ..	1·6
Philip Schuyler.	
Original hatch corners	2·0
Corners of house structure ..	1·5
President Wilson. Bulwark plating	4·6

(4) " The inefficiency of plating due to unfairness had the effect of reducing the effective moment of inertia and shifting the neutral axis, thereby modifying the stress distribution. In addition, the stresses in the vicinity of longitudinal stiffening were increased by the unfairness of the plating."

(5) " Apart from the eccentricities which occur at over-lapped joints, the initial unfairness was found to be greater in the welded than in the riveted ship."

This unfairness was also found to be true in the case of the welded tanker Neverita and the riveted tanker Newcombia. The panels of plating in the riveted ship have the benefit of the stiffening influence of the riveted overlaps.

(6) " Although the heart-of-plate stresses in the unfair plating were usually lower than those which would have occurred in the same plating if it had remained plane, the surface stresses were often higher owing to the effects of local bending."

(7) " In the case of the welded Ocean Vulcan the unfairness was at some places such that the combined local bending and heart-of-plate stresses were sufficient to cause local yielding of the material, which increased the unfairness."

(8) " No significant difference was found between the flexural rigidities of the welded and riveted ships. In the particular cases examined, the welded ship had slighly the greater flexibility."

AGREEMENT BETWEEN THEORY AND OBSERVATIONS

(9) " Agreement between the theoretical and observed values of deflection in the two ships examined was obtained after taking account of superstructures, local inefficiencies of unfair plating, discontinuous members and other such effects."

The observed deflections in both ships, after being corrected for temperature effects, were about 10 per cent. greater than the theoretical.

The total deflection was given by $y = y_b + y_s$. That due to bending y_b was calculated using:—

$$y_b = \int \frac{M}{E\,I}\,dx\,dx$$

where I = moment of inertia of all the continuous material in the section except deck erections, M = bending moment, and E = Young's modulus.

The shear deflection was calculated from the approximate formula:—

$$y_s = \int \frac{F\,L}{A\,N},$$

where A = web area only of the section, F = shearing force, L = length of the section, and N = shear modulus.

This formula was used for ease in calculation rather than the more exact, but more laborious form propounded by Lockwood Taylor, in his shear lag theory, i.e.,

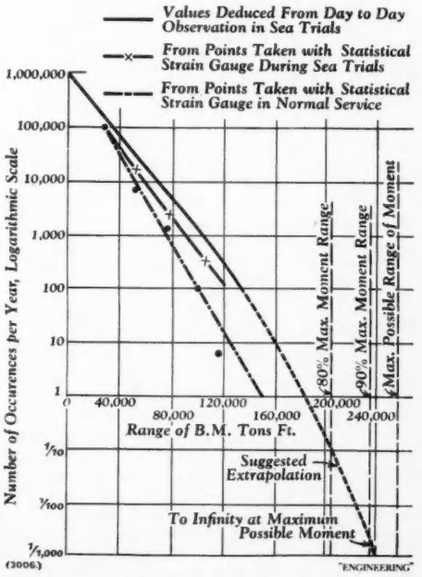
$$y_s = \frac{1}{N}\iint w \int y \int \frac{m}{24\,I^2\,t}.$$

Using the latter will give an addition of about 1 per cent. in the total deflection.

The temperature deflections averaged about $\frac{1}{8}$ in. and it was calculated that the theoretical temperature deflection for both ships would be 1 in. for 22 deg. F. difference of temperature. In the case of the Neverita it was observed that the ship hogged by about 1 in. when the rise in air temperature exceeded the rise in sea temperature by 24 deg. F. However, if it is assumed that temperature deflections result from the unrestricted expansion of the upper deck relative to the bottom then the calculated value would be 1 in. per 16 deg. F. This implies that the partial restriction of free thermal expansion by attached structural members not having the same rise in temperature, reduces the overall calculated temperature deflections by about one third.

In the static trials on the destroyer Albuera, the calculated temperature deflection, using Hurst's method (I.N.A., 1943), was 1 in. per 18 deg. F.

(10) " No conclusive evidence of rivet slip in the butts or seams was found within the range of bending moments and shear forces applied during these experiments, but the lower stress concentration factors found in the riveted ship suggest that rivet slip may have occurred in the vicinity of discontinuities."



The ranges of bending moment in tons-feet are plotted against the number of occurrences per year. A range equal to 80 per cent. of the maximum possible bending moment is likely to occur once in 10 ship-years.

MAXIMUM RANGE OF BENDING MOMENTS

(11) " The maximum range of bending moments at sea occurs when the ship's course is normal to the wave crests, and when the wave length is approximately equal to the ship's length."

This conclusion is borne out by other experimenters, particularly Schnadel in the San Francisco trials of 1934 (I.N.A., 1938).

Calculations for the vertical bending moments were made using wavelengths varying from l = 0·4 L to l = 2·0 L, where L is the length between perpendiculars, and the heights of the waves used were obtained from a formula derived from a thorough analysis of wave heights collected from all available sources, i.e. :—

$$h = 24\left(1{\cdot}0 - e^{-\frac{l}{200}}\right) + \frac{l}{30},$$

where h is the upper limit of wave height for any wave, in feet and l is the length of the wave in feet.

The calculations were made for three different loading conditions involving changed displacements, and the waves were assumed to be normal to the ship's length. It was shown that the wave bending moment ranges were largely independent of the loading, and the maximum value of 255,000 tons-feet occurred when the wave length and ship's length were approximately equal. This bending moment gives a stress range in the top of the sheerstrake of 11 tons per square inch. However, if a standard $\frac{L}{20}$ wave were used, then the most severe waves would have a length of 1·2 L. It was also found that the standard strength calculation, neglecting the Smith correction, gives a range reduction of 35 per cent. in the loaded condition, and 20 per cent. in the light condition.

The Smith correction (I.N.A., 1883) is made in order to take account of the fact that there are variations in the fluid pressure in a wave form due to the circulation of the particles of water.

(12) " When the ship is inclined to the direction of the wave advance, horizontal bending moments arise, the magnitude of which, under certain conditions, may exceed those of the co-existing vertical bending moment."

(13) " The maximum combined stress effects of the vertical and horizontal bending moments do not exceed, at the gunwhale and the bilge, the highest value for the vertical bending alone. The combined effects do, however, influence the maximum stresses in the side plating."

(14) " Stresses caused by axial compressive forces are only a small percentage of those caused by the maximum vertical bending moment."

(15) " The stresses caused by the torsional forces due to wave action may be neglected."

MAXIMUM WAVE HEIGHT

(16) " For waves not longer than 800 ft., the maximum wave height, within the bounds of

* Transactions of the Society of Naval Architects and Marine Engineers (U.S.A.).

practical probability, may be expressed by the formula:—

$$h = 21{\cdot}5\left(1{\cdot}0 - e^{-\frac{l}{200}}\right) + \frac{l}{33},$$

where h is the height of the waves in feet and l is the length of the waves in feet.

The above formula, which gives a wave height equal to 90 per cent. of the maximum possible wave height, is based on evidence collected from a statistical strain gauge fitted during the Ocean Vulcan sea trials and on additional oceanographical information. From this it appeared that a range equal to 80 per cent. of the maximum possible bending moment range may be expected once within 10 ship years, and 90 per cent. of the maximum once within about 1,000 ship years. This is shown in the graph on page 109.

The use of this formula would give a height of 31·5 ft. for a wave of length equal to the Ocean Vulcan (L.B.P. = 416 ft.), i.e., a ratio of length to height of 13·2. This is considerably greater than the ratio of 20 that is used in the standard strength calculation, which would give a wave height of only 20·8 ft.

(17) "Theoretical and experimental evidence indicates that in the equations which relate the motions of a ship among waves to the resulting bending moments the dynamic terms tend to cancel each other, and only become important under conditions of resonance, which, however, are unlikely to occur under severe wave conditions."

The dynamic forces referred to are those caused by the accelerations and decelerations due to the heaving and pitching motions. The heaving correction is sometimes referred to as the "Read Correction" (I.N.A. 1890) and the pitching correction has been extensively studied by Alexander (I.N.A. 1911).

(18) "For the ships considered, a reliable estimate of the vertical bending moment due to waves of any given dimensions may be obtained by assuming the ship to be in static equilibrium on a trochoidal wave form, and applying the Smith correction."

The addition of the Smith correction to a standard strength calculation means a relatively large increase in the amount of work needed to obtain the corrected buoyancy curve. The justification for omitting this at present lies in the fact that all standard strength calculations are used on a comparative basis and are not intended to derive actual stress values for the assumed loading conditions. Therefore, any error is not material as long as it is perpetuated in all similar calculations, and the derived stresses are used only for comparison between similar ships. One other reason put forward for its omission is the fact that the inclusion of the correction reduces the value of the maximum bending stress, and therefore the margin of safety.

However, there is now justification for the assumption that the theoretical calculation, with the addition of the Smith correction does, in fact, give a realistic value to the stresses as measured at sea. It would, therefore, be advantageous to calculate the value of the Smith correction for each ship. Champness showed (I.N.A. 1928) that the reduction in the maximum statical bending moment for a 400-foot ship was about 15 per cent.

SLAMMING STRESS

(19) "Slamming was not extensively investigated because of the unsuitability of the experimental equipment. It was noted that the maximum slamming stress amidships was about $\pm 1\frac{1}{2}$ tons per square inch at a frequency equal to the ship's two node vertical vibration. Slams were observed only in the ballasted condition and numbered approximately 2,000 in one year's normal service. The stress caused was additive to the sagging stress but not in general to the hogging."

The correlation of the stress to a frequency of vibration has been noted by many experimenters, and the question of impact stress is one which has given rise to much experimental work in the United States. Another factor of considerable importance is the duration of impact, and the phase difference between the application of the impact force and the vibrating body.

It is possible that, during slamming, the period between slams will coincide with the pitching period. If, therefore, a second slam occurs at the proper phase of the vibration cycle then the impact loads and stresses caused by the second slam may be added to the residue left by the first. These forces may build up until a fracture or buckle occurs, probably at some discontinuity, and in the limit such a fracture may lead to the loss of the ship.

STOKER FOR BURNING SLURRY

About six million tons of slurry lie in settling ponds at the collieries of Great Britain. Slurry consists of fine particles of coal and soluble shale rejected from washeries, has a high ash and moisture content, and its calorific value is at the low figure of between 6,000 and 8,000 B.Th.U. per lb. It is a wet and sticky fuel to handle and cannot be moved on rubber belts, scraper conveyors or bucket elevators, the most effective way to handle it being by a mechanical grab. In spite of these disadvantages, slurry represents a useful source of fuel, and the National Coal Board have recently completed an experiment burning slurry using a special type of mechanical stoker.

The Martin stoker, which is of German design, has been adapted and installed at Llay Main Colliery in North Wales. It has been consuming about 650 tons of slurry a week, thereby replacing the 450 tons of washed small coal previously used at this colliery to raise steam on watertube boilers fired by chain-grate stokers and hand-fired Lancashire boilers. Savings of £1,000 a week have been achieved as a result of changing the fuel and the experiment at Llay Main indicates that raw slurry can be burned satisfactorily on a modern watertube boiler; combustion is completely smokeless at all loads.

At Llay Main the fuel is taken from the pond by mechanical grab, loaded into wagons, transported over a weighbridge and transferred into a vertical-sided 60-ton bunker. At the base of the bunker are screw feeders with disintegrators mounted at the delivery end to break up the fuel before it passes down a wide feed chute. On entering the combustion chamber the fuel is sprayed on to the fire bed by air jets; the fire grate is inclined and incorporates reciprocating fire bars which agitate the fuel as it travels to the lower end to be discarded as ash. Slurry has a high moisture content which makes it difficult to spread; there must therefore be constant movement among the particles so that the fuel bed is continuously broken up. This combustion system ensures that hot fuel is continuously mixed with incoming coal and wet material, and even in the winter when ice and snow were mixed in with the slurry there were no difficulties with ignition. It has also been proved that the Martin stoker can deal with a fluctuating load, which is important in the operation of colliery boilers; the fuel bed can be banked-down for as long as two or three days and steam can then be raised quickly, merely by starting up the fans and feeding fuel to the grate.

The new plant went into operation on January 9 and has been in routine operation ever since. By June 1 it had steamed for about 3,000 hours, burnt about 14,000 tons of slurry and carried about 40 per cent. of the regular colliery steam load. The installation cost £130,000, and includes a 50,000-lb. an hour watertube boiler and accessories, the Martin stoker, coal and ash-handling plant, feed-water treatment plant and other equipment. Further installations are being considered, and one is already under construction at Bowhill Colliery in Scotland.

"WORKING IN THE SHADE"

AIR REGISTRATION BOARD'S REPORT

In the report of the Air Registration Board for 1954-5 Lord Brabazon of Tara states that the technical problems encountered, both by their nature and extent, made this the most difficult year in the Board's history. He describes it as "working in the shade with only occasional glimpses of the light."

The biggest shadow was that cast by the accidents to Comet aircraft, but Lord Brabazon makes only brief reference to them and to the subsequent inquiry as so much has already been written on the subject. He pays great tribute to the part which the officers of the Board played during the investigation. The already large programme on fatigue testing had been increased, using all the new techniques and devices now available.

The acceptance of the British certificate of airworthiness for the Viscount by the United States authorities is recorded—the result of much negotiation made difficult largely because the Americans have not yet published a code of domestic requirements for turbine-engined aircraft. Work has been continued on the various sections of British civil airworthiness requirements. The revision of Section C, which deals with engines and propellers, is now complete and the third issue will shortly be published. A second issue of the section on rotor-craft is also being prepared. The Council of the International Civil Aviation Organisation have reached the conclusion that international standards should be reviewed with the object of presenting them in a broader and more objective manner, reinforced by detailed "acceptable means of compliance" for the more important.

No major aircraft types reached certification stage during the year. The Westland S55 was the only prototype of note. Investigation continues with several other types. The Minister of Transport and Civil Aviation has agreed to permit ultra-light aircraft to fly on the recommendation of the Popular Flying Association. In the main, the Board's procedure and requirements will be followed. Lord Brabazon hopes that the principle of dual responsibility involved is fully appreciated.

Flight tests have been carried out on some 125 aircraft during the year. Much effort has been directed to the Britannia, and tropical trials were made on York, Hermes and Tudor machines. Other models tested included Pioneer, Auster, Viscounts 720, 724 and 737, Heron 2 and Sparrowjet. Pilots examined for performance requirements averaged 25 a week, of whom about 75 per cent. were successful. Pilots belonging to the Board train regularly with B.O.A.C. and Lord Brabazon emphasises that they thus gain much airline experience.

A further decrease in work on piston engines is recorded; the compound piston engine in particular appears to have been virtually abandoned. Three entirely new turbo-propeller engines have now entered the initial period of their development, and the development of a number of small gas-turbines now appears certain, with particular application to helicopter design. The enormous amount of effort now being devoted to this last type of aircraft will become much more apparent during the next twelve months. Two gas-turbine designs, without shaft drive to the rotors, are in course of development, one with rotor-tip combustion and the other with rotor-tip efflux.

CHADDERTON B POWER STATION

COOLANT SUPPLY DRAWN FROM SEWAGE EFFLUENT

The 240-MW Chadderton B power station in the North West, Merseyside and North Wales Division of the Central Electricity Authority was formally opened by Councillor F. Kenyon, chairman of the Consultative Council of the local Area Board, on Friday, July 8. It is situated about four miles from Oldham adjacent to the 35-MW station, which was formerly owned by the Corporation and was then known as Slacks Valley. At present, two 60-MW sets are in operation but a further two are under construction. The consulting engineers are Messrs. Kennedy and Donkin, 12 Caxton-street, London, S.W.1, with whom Messrs. Mouchel and Partners, 38 Victoria-street, London, S.W.1, are associated for the civil engineering work. A view of the exterior of the station is given in Fig. 1.

The site is bounded on the south side by a railway and is intersected by the Rochdale canal. Oldham Corporation sewage works form the northern limit. The ground under the top soil consists of 3 to 4 ft. of sandy clay with patches of running sand, below which is soft clay at depths from 6 to 10 ft. To provide the foundations more than 7,000 *in situ* piles 18 in. in diameter were placed at 3 ft. 6 in. centres, the average length being 40 ft. under the main buildings and cooling towers and 30 ft. under the ancillary buildings. These piles are surmounted by rafts of beam and slab construction. The main building, which is 515 ft. long by 320 ft. wide, is a riveted structural frame work with brick panels. The floors are granolithic with a tile finish in the turbine room and on the firing platform, while the main roofs are of reinforced concrete with Lenscrete glazing. A prestressed concrete bridge with a span of 112 ft. connects the administration block and turbine house. This consists of two side beams, 5 ft. deep, which were pre-cast off the site in four sections. The concrete roof is supported on *in situ* columns with continuous glazing between the side beams and the roof. The main contractors for the civil engineering work were M. J. Gleeson (Contractors), Limited, Chesterfield-road, Sheffield, the Franki Compressed Pile Company, Limited, 39 Victoria-street, London, S.W.1, and Edward Wood and Company, Limited, Trafford Park, Manchester, 17.

COAL SUPPLY AND STEAM RAISING PLANT

The coal consumed in the station is mainly rail borne, being delivered from wagons into two weigher-tipplers, each with a capacity of 35 tons. A third tippler with an independent weigh-bridge is installed to deal with road-borne coal. These tipplers discharge on to two conveyors with a capacity of 250 tons per hour, which take the coal into the station and deliver it on to two further conveyors which run over the bunkers, the capacity of the latter being 540 tons per boiler. The main contractors for this portion of the plant were Simon-Carves, Limited, Cheadle Heath, Stockport, the tipplers being constructed by Mitchell Engineering, Limited, Bedford-square, London, W.C. Coal can also be discharged into a store, with a capacity of 70,000 tons, which is equipped with an International Combustion drag scraper and a radial-arm stacking conveyor. The store is semi-circular in plan with a radius of 500 ft.

The steam-raising plant, which is also of Simon-Carves manufacture, will ultimately consist of seven boilers of which four are at present in operation. They are of the high-head natural-circulation radiant-heat type with individual outputs of 360,000 lb. of steam per hour at a pressure of 950 lb. per square inch and a temperature of 925 deg. F. With them are associated Melesco superheaters of the self-draining type, Senior economisers and Howden-Ljungstrom air heaters. They are fired by pulverised coal, there being three mills per boiler. The total heating surface of this combination is 143,976 sq. ft., the volume of the combustion chamber being 25,450 cub. ft. and the heat release 18,600 B.Th.U. per hour per cubic foot. Automatic control is effected by Electroflo pneumatic equipment. Two forced and two induced draught fans of Howden manufacture are installed. On leaving the air heaters the gases pass through electrostatic precipitators into two 365-ft. high brick chimneys for which M. J. Gleeson (Contractors), Limited, and P. C. Richardson and Company (Middlesbrough), Limited, Middlesbrough, are the contractors. One of these chimneys is still under construction. The furnace ash is conveyed by hydraulic sluices to a sump whence it is discharged into lorries; and the dust and grit by vacuum extractors to receivers, prior to wetting for road disposal. A typical boiler control board is shown in Fig. 2.

HYDROGEN-COOLED MACHINES

The generating plant will comprise four 60-MW Metropolitan-Vickers impulse turbines with duplex exhausts, which will be coupled to hydrogen-cooled alternators with direct-driven exciters, the generating voltage being 11·8 kV at 3,000 r.p.m. One of these sets, two of which are in commission and are of the three-cylinder type, is illustrated in Fig. 3. The other two will be two-cylinder close-coupled units. The turbine rotors of the three-cylinder sets have eleven stages of high-pressure blading, thirteen of intermediate and two flows of three stages of impulse blading in the low-pressure section with a final double-tier Baumann exhaust. The condensers are of the two-pass shell type with a designed vacuum of 28·7 in., the inlet and outlet water temperatures being 65 deg. and 76·6 deg. F. respectively, and the cooling surface 60,000 sq. ft.

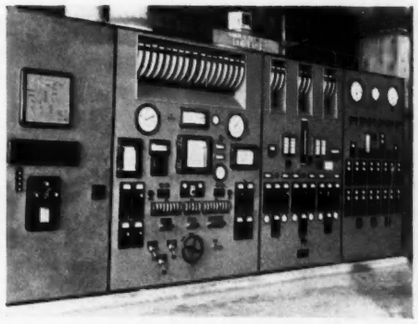


Fig. 2 Control panel for No. 1 boiler. Automatic control equipment is used.

Each machine is provided with two electrically-driven extraction pumps, both of which are capable of handling the full quantity of the condensate. The air extractors are of the surface intercooling type and there are two 100 per cent. ejectors per set as well as a quick start ejector and a vertical de-aerator. The feed heating system for each unit consists of two low-pressure and two high-pressure heaters, the final feed water temperature being 380 deg. F. Six of the boiler feed pumps, which are being manufactured by Mather and Platt, Limited, Newton Heath, Manchester, will be electrically driven and three steam driven, the output of each being 600,000 lb. per hour.

EFFLUENT COOLING

The cooling medium for the condensers consists of effluent which is drawn from the adjacent Corporation sewage works. It will be used in three towers, each of which is capable of cooling up to 3,825,000 gallons per hour through a range of 12 deg. F., the contractors being F. Mitchell and Sons, Limited, River-place, Hulme, Manchester, and the Davenport Engineering Company, Limited, Bradford. Each tower is 310 ft. high with a base diameter of 210 ft., the capacity of the pond being 1,250,000 gallons. The towers are connected to the condensers in the turbine room through reinforced-concrete ducts 8 ft. in diameter, the circulation being maintained by Mather and Platt pumps.

The quantity of circulating water supplied by the pumps is 50,000 gallons per minute for each of the alternator sets. The water is chlorinated from two high-capacity master vacuum solution-feed sets which are capable of handling a max-

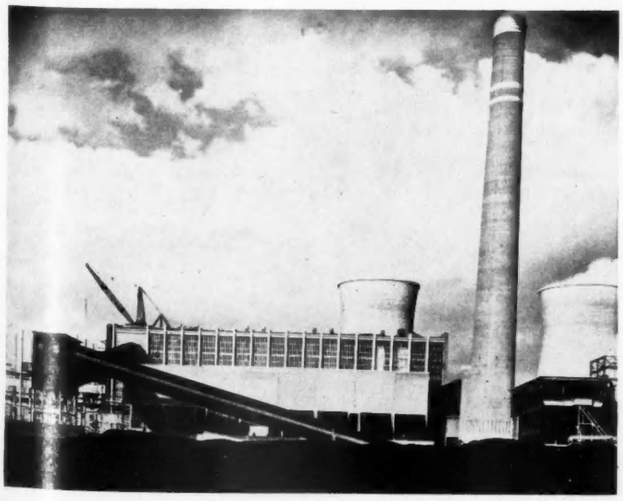


Fig. 1 Chadderton B power station has a designed capacity of 240 MW. When complete, there will be two chimneys and three cooling towers.

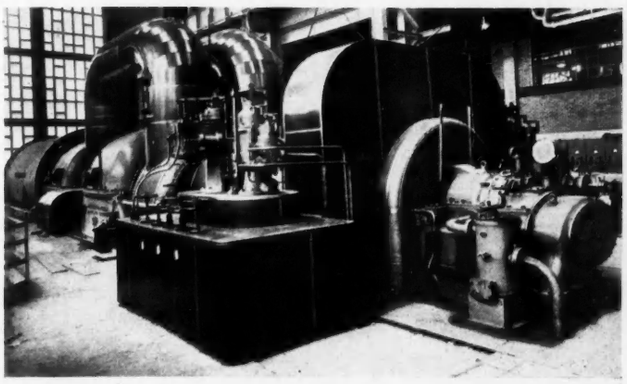


Fig. 3 One of the two three-cylinder 60-MW hydrogen-cooled turbo-alternators. Two two-cylinder sets are yet to be installed.

imum of 6,000 lb. of chlorine in 24 hours. They are designed for automatic intermittent operation under the control of an electric programme clock. The solution is injected on the suction side of the circulating pumps.

For water treatment, there are three sand filters and base exchange units, each having a capacity of 500 gallons per hour. Make-up supplies are taken from the town's water system. Four welded-plate storage tanks are to be installed on the tank floor which is 106 ft. above the basement level. Each tank has a capacity of 13,100 gallons.

Each of the two 60 MW alternators now in operation is connected to a 72 MVA, 11·8/33 kV transformer of Metropolitan-Vickers manufacture, and thence to duplicate busbar switchboards with a rating of 1,500 MVA. These switchboards, which were manufactured by Ferguson Pailin, Limited, Higher Openshaw, Manchester, 11, are housed in separate rooms which are connected by cables. They are also connected through two 60-MVA 33/132 kV transformers to an existing outdoor grid substation, through two 30-MVA 33/6·6-kV transformers to the Chadderton A station, and through group reactors to two 500-MVA distribution switchboards from which the local feeders are supplied. The other two generators will be connected to the grid substation through 72-MVA 11·8/132-kV transformers.

All the circuit-breakers are of the vertically isolated phase-segregated design and are arranged for off-load busbar selection by the physical transfer of the circuit-breaker. Operation is effected from a room in the administrative block in which corridor type control and relay boards are installed. The circuit conditions are indicated on a mimic diagram by coloured lamp type semaphores. A separate desk is provided for controlling the generator load.

The station auxiliaries are supplied from 6 MVA, 11/3·3 kV unit transformers which are directly connected to each alternator, the manufacturers being Bonar Long and Company, Limited, Dundee, and the Electric Construction Company, Limited, Wolverhampton. The 3·3 kV switchboard was constructed by the English Electric Company, Limited, Kingsway, London, W.C. 2 and from it a supply is given to the larger auxiliary motors. The remainder are fed through 3·3 kV/415 volt transformers, and 415 volt switchboards. Two 10 MVA, 33/3·3 kV station transformers are to be installed, so that general and emergency services can be supplied from the local system.

The present Controller of the North West, Merseyside and North Wales Division is Mr. A. R. Cooper, while the Chief Generation Engineer Construction is Mr. C. R. Watson Smythe and the Station Superintendent, Chadderton B, Mr. F. Dewhurst.

LONG-LENGTH AND BI-METAL CENTRIFUGAL CASTINGS

CONTROLLED FLOW OF METAL IN PERMANENT MOULDS

Centrifugal casting of tubular objects was first used in the production of cast-iron pipes, and the process is now well-known, both sand and metal moulds being used. Many other products, particularly cylinder liners, are well adapted for production by centrifugal casting, and Sheepbridge Stokes Limited, a company in the Sheepbridge Engineering Group, Chesterfield, who pioneered the centrifugal casting process for cylinder liners in this country, have been in regular production of such components in cast iron for 30 years, and in steel for 15 years. Sheepbridge Alloy Castings, Limited, another company in the Sheepbridge Group, have also been engaged in similar work for some time, and at their factory at Sutton-in-Ashfield, Nottinghamshire, a considerable experience has been built up in the production of gas-turbine and other alloy-steel components by centrifugal casting.

The process need only be described briefly. A permanent metal mould is mounted on a face-plate or otherwise carried so that it can be rotated continuously by power. Molten metal is poured into the mould as it rotates, and centrifugal force causes the metal to fly outwards to the inner surface of the mould and form a thin, hollow casting. Rotation is continued until the casting has solidified. The machine is then stopped and the casting, which has contracted sufficiently to withdraw it from the mould walls, is extracted. Horizontal machines of the type shown in Fig. 1 are used by Sheepbridge for the production of castings from 4 in. to 30 in. outside diameter.

For longer and heavier castings, both in this range and of greater diameter, the tendency is to use vertical machines one of which is illustrated in Fig. 2. These vertical machines are used for castings ranging from 24 in. to 40 in. in outside diameter. Within the range stated it is also possible to produce shaped castings by introducing suitable refractory cores into the mould before the metal is cast. A certain amount of bi-metal work has also been done. An example of the former type of work is provided by a cylinder liner for a two-stroke engine, which has its ports cast in, leaving only a minimum of machining to be done in addition to the normal boring and turning. A typical bi-metal component, made, however, on specially-designed machines, is an aircraft brake drum, which consists of a pressed-steel outer shell with a liner of cast iron cast in it, so combining the light weight of steel with the frictional properties of cast iron.

Fig. 2 For thick-walled castings and components up to about 40 in. outside diameter a vertical machine, as shown here, is used.

One or other of the two types of machine mentioned, used in conjunction with electric high-frequency or arc furnaces for steel and alloys, or with a cupola for cast iron, is a satisfactory method of producing a wide range of articles, but the length which can be cast is limited. With high-grade cast iron or alloy steels the length of casting produced in metal moulds by Sheepbridge hitherto has not usually exceeded three or four times the diameter, and was often less. The difficulty in producing long castings is to make the metal flow smoothly and uniformly from one end of the mould to the other. Various methods have been developed to overcome this difficulty, the principal ones being the retractable machine and the sand mould. By retracting the mould while the metal is being poured it is possible to direct the flow of molten metal as required, and so to fill the mould to its full length before the metal solidifies. The sand mould has a much lower rate of heat transfer than the metal mould, and

Fig. 1 Horizontal machine for centrifugal castings in the range 4 in. to 30 in. outside diameter.

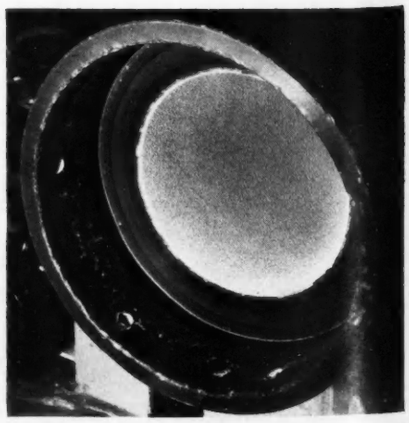


Fig. 3 The characteristic regular roughness of the sprayed coating is visible in this illustration of a mould ready for casting.

the metal therefore remains fluid longer and so can run the full length of the mould.

CONTROLLED COATING ON METAL MOULDS

A more recently developed process for casting long lengths is that of the United States Pipe and Foundry Company, Burlington, New Jersey, U.S.A., and now operated under licence in this country by Sheepbridge Alloy Castings at Sutton-in-Ashfield. The " Burlington " process is basically similar to the older horizontal casting method, but the use of a controlled-characteristic coating on the metal moulds enables the metal to flow without difficulty to a considerable length. As at present operated at Sutton-in-Ashfield, the process makes it possible for castings up to 10 ft. long to be made, and it is intended to increase the length to 12 ft. 6 in. or more in the near future. The diameters range from 3 in. to 3 ft., the practicable radial thicknesses varying with the diameters. An extremely wide range of metals can be cast by the new process in addition to the normal grades of cylinder-liner irons. The metals in normal production include cast iron, low-alloy and mild steel, stainless austenitic and martensitic steels, heat-resisting alloys, and certain non-ferrous alloys such as phosphor-bronze, brass and aluminium-bronze. The " Burlington " process is also particularly well suited to bi-metal casting, and it is possible, for instance, to produce a centrifugal casting having the outer shell of mild steel, while the inner lining is of stainless material. The two metals are firmly bonded, the second being cast while the first is still plastic.

MOULD PREPARATION

A special machine is used for preparing the moulds for casting by the " Burlington " process. The machine, which is illustrated in Fig. 4, consists of a mechanically-reciprocated carriage on which a spraying unit is mounted, and a set of power-driven rollers for rotating the mould while the sprayed coating is applied. A mixture of refractory powder, Bentonite and water is sprayed on to the inner surface of the mould, which is rotated at about 1,000 linear ft. per minute while the spraying unit is fed forward to traverse the nozzle over the whole length of the mould. The mould is hot from the previous cast, or is pre-heated by gas burners at the beginning of a casting run, and the temperature of 450 to 500 deg. F. is sufficient to dry the layer of coating as it is applied. Sufficient passes of the spraying head through the mould are made to give the required thickness of coating, and the machine is then stopped and the mould lifted off by crane, ready for casting. The regular, controlled roughness of the coating, which is clearly visible in Fig. 3, causes the molten metal to advance smoothly, with a firm, rounded wave-end, to the full extent of the mould, and there is no splashing or irregular movement.

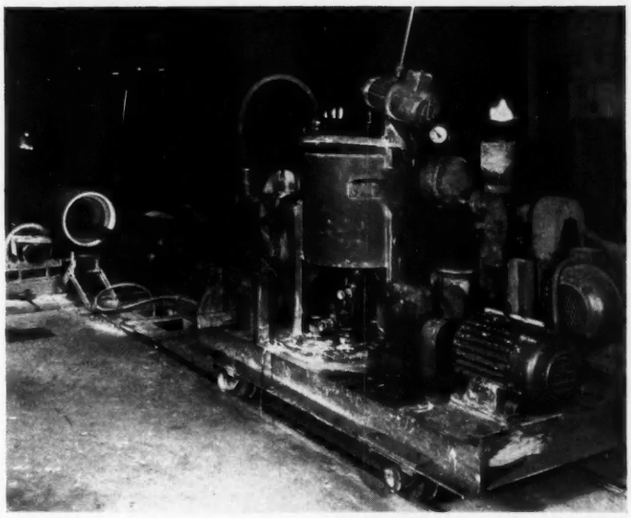


Fig. 4 Mould preparation for the " Burlington " process is carried out on a special machine which traverses the spraying head while the mould rotates.

CASTING AND STRIPPING

The prepared mould is taken by the crane straight to the casting machine (Fig. 5), which is immediately adjacent to the coating machine, and lowered on to a set of rollers on which it is rotated relatively slowly until the metal is ready for pouring. A gas burner is inserted in the mould to keep it hot if the length of the waiting period justifies it. Immediately prior to pouring the molten metal, the speed of rotation is increased to 2,000 to 3,000 linear ft. per minute, and this speed is maintained during casting and solidification. The metal is poured from an orthodox ladle suspended from a weighing machine on the overhead crane, and the exact weight of metal required is poured through the spout which is visible at the rear end of the machine in Fig. 5. Rotation of the mould continues until the casting has solidified, when contraction is sufficient to enable it to be withdrawn without difficulty.

For this purpose, the mould is lifted from the casting machine and transferred to a fixed stand with its end abutting against a fabricated steel frame. A hook or clip is then attached to the casting, and by means of a wire rope and pulley the crane draws the casting out of the mould on to a roller conveyor for final cooling or heat treatment as required. If a bi-metal casting is being made the rotation of the mould continues until the first metal is plastic, and the second cast is then made with the mould running at the same speed. Stripping follows after solidification in exactly the same way as with a single-metal cast. The hot mould is then returned to the spraying machine, a fresh coating is applied, and the casting cycle re-commences.

Centrifugal casting has long been used for the production of components to very exacting specifications, consequently the rejection rate may in some cases be relatively high. With the " Burlington " process, however, the casting conditions are such that the number of rejections is considerably reduced.

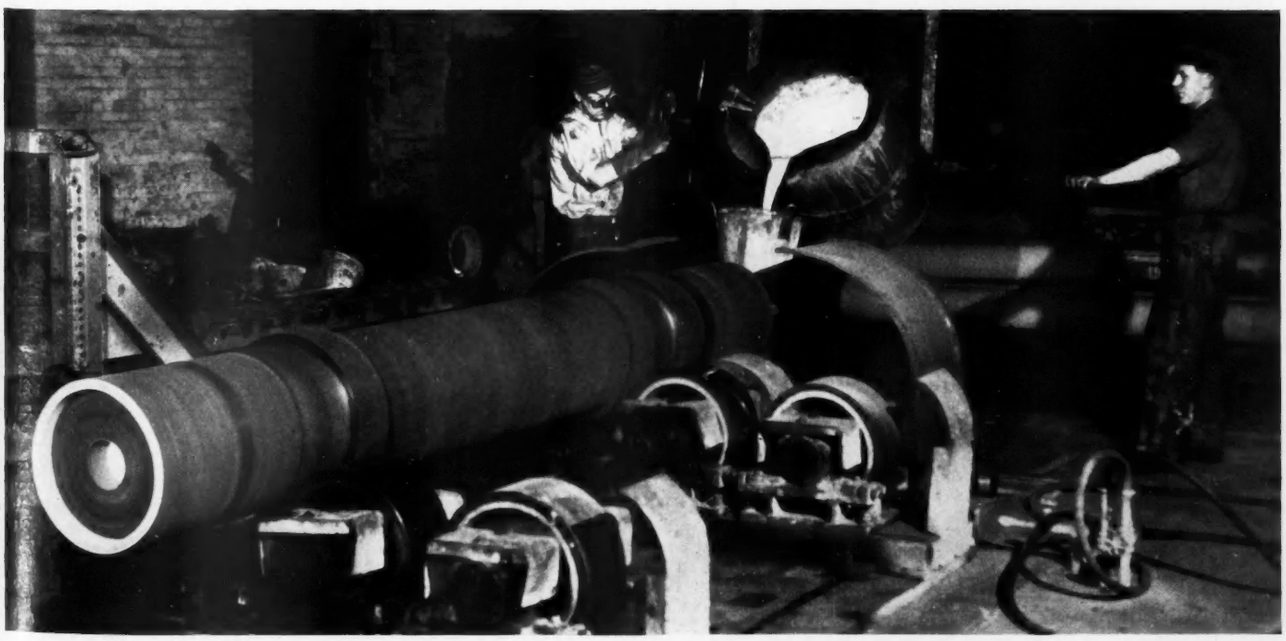


Fig. 5 The mould is rotated by power-driven rollers while a weighed quantity of molten metal is poured in from a ladle.

Fig. 1 New laboratories of the Development Department of I.C.I.'s Paints Division will speed up the application of research results to manufacturing processes. The flat roof can be used for weathering racks.

Fig. 2 A laboratory for the development of new industrial paints. Heating is by low-pressure hot water circulating through pipes in the ceiling. The excellent natural lighting of the laboratory is apparent.

DEVELOPMENT: THE LINK BETWEEN RESEARCH AND PRODUCTION

NEW LABORATORIES FOR I.C.I. PAINTS DIVISION

The results of research are often wasted because of the time lag between the research and its application to production. The linking stage, that of development, is one of great importance in modern industry, and one which is in many cases neglected. The Paints Division of Imperial Chemical Industries Limited, Slough, Buckinghamshire, have not fallen into this error. They have for long had a development section, and have recently built new laboratories, illustrated in Fig. 1, to make the work of their research department more quickly available to their manufacturing divisions. The opening ceremony took place on June 28.

TWO-WAY FLOW OF INFORMATION

The function of the Paints Division Development Department is to apply research discoveries to the improvement of industrial and decorative paint products and processes. It has laboratories at the two main manufacturing sites of the Paints Division—Slough, Buckinghamshire, and Stowmarket, Suffolk. In addition, it operates a large exposure "farm" at Stowmarket for assessing the performance of paints when exposed to the weather.

The Department has a staff of over 150, divided into sections of from six to ten men, each under the direction of a senior graduate. Each section deals with paints devised for a particular industry or group of industries. The specialised knowledge of the requirements of particular industries which each section acquires is of considerable importance—for practically all paint-using industries require paint with a different balance of properties. Over 2,000 types of paint may be manufactured regularly during the year, and in the case of large individual paint-users finishes are often made to fit into a tight manufacturing schedule.

The Development Department maintains close contact with all the paint-using industries, either directly or through the Division's sales and technical service representatives. The information thus obtained on the requirements of paint-users is vital if the development chemist is to provide the paint products necessary to keep pace with the general developments in industry. The Department's main source of inspiration, however, is its associated Research Department, which is constantly carrying out work on new polymers, resins, pigments and solvents. The Research Department also studies the chemical and physical problems arising in either the manufacture or use of paint, and provides a constant flow of new information to the Development Department. The substantial and progressive improvement in paints over the past 20 years is partly the result of novel ideas and partly of the cumulative effect of a large number of minor improvements.

The new wing of the Development laboratory at Slough will double the existing accommodation for the Development Department. Staff will be housed on two floors, designed to give a considerable degree of flexibility in internal arrangements. For this purpose, internal columns have been eliminated, extensive use is made of demountable partitioning, and services are moduled to some extent.

In addition to the latest laboratory-scale paint-making machinery, paint-testing equipment and photographic laboratories, the new block has two testing rooms in which the atmosphere is automatically controlled to within narrow limits. These testing rooms make it possible to study the behaviour of paints under a variety of climatic conditions. In one room, the atmosphere can be controlled at any temperature in the range 0 deg. C. to 40 deg. C. and relative humidity 50 per cent. to 95 per cent. at any temperature in the range. In the second room there is no humidity control, and the temperature may be controlled between outside ambient and 40 deg. C. Fig. 2 shows a laboratory for the development of new industrial paints, and gives a good idea of the excellent working conditions.

POST-TENSIONING OF STRUCTURAL BEAMS

One of the more interesting features of the construction is the structural frame. Before a final decision was reached various alternatives were investigated, and the construction adopted gives freedom from internal supports.

Basically, the structure is a precast concrete framework on continuous strip foundations. All main beams are prestressed and the columns are of normal reinforced concrete construction. The main beams were erected as plain 27 in. by 12 in. wide pretensioned units 45 ft. long and, in certain cases (the first floor beams and certain roof beams), ducts were cast in with cables for subsequent post-tensioning by the Gifford-Udall system. All main beams were designed with a shear key on the top surface. After erection and curing of the structural slab, post-tensioning was carried out on the resultant composite T beams. Main columns were designed with suitable pockets for erection in one piece and so shaped that they are finally set completely flush in the 13½ in. cavity wall panels and plastered over. The columns were erected in preformed pockets in the foundations. The floor and roof slabs are formed with the "St. Paul's Cray" type flooring manufactured by the Concrete Development Company, Limited, 1, Queen Anne's Gate, London, S.W.1, who also carried out the design and manufacture of the precast frame. The "St. Paul's Cray" flooring is a hollow pot construction using pretensioned ribs and *in situ* topping, the topping being thicker over main beams to form the flange of the composite T beam.

The frame is in general clad with 13½-in. thick brickwork incorporating a 4½ in. wide cavity. The building was laid out on a longitudinal 4 ft. module, and the mullions of the purpose-made windows follow this module throughout the length. Demountable partitioning has been used throughout, the sub-division of the floors being arranged according to the module, thus affording flexibility for any possible future change. In the private offices and conference rooms the partitions are sound-insulated by the use of sand filling and double-glazing.

CEILING HEATING

There is no need for mechanical ventilation in most of the building and ventilation for the most part is by means of the opening windows. However, in certain rooms there is a nuisance from the fumes arising from open solvent baths and quantities of paint, and mechanical ventilation is provided by ducts in the roof space and low-level extract ducts formed in the floor. In cold weather, heated air admitted through this system will supplement the normal ceiling heating to allow for the increased air movement required for ventilation of these spaces. The plant for this small plenum system is located in the existing building and the quadrangle.

The provision of ceiling heating, as opposed to a more traditional form, had various advantages, including the absence of obstructions on internal walls and the incidental accoustic ceiling effect. The ceiling is heated by low-pressure hot water from a calorifier installation fed with steam from the main factory supply. Main headers above the corridor ceilings supply grids of piping in the rooms to which 2 ft. square perforated light gauge aluminium panels are clipped. Above the grid piping is a glass fibre blanket. The whole installation is thermostatically controlled by means of an electronic control system.

The services installation to the laboratories is restricted to cold water, electricity and compressed air and the piping as a whole is concealed beneath the false ceiling with some electric conduit chased in the ground floor to island benches. Electric lighting fittings also are recessed in the ceiling and their position may be altered if required. The main roof will be used for weathering racks for paint trials, and the promenade decking consists of built-up roofing surfaced with 1 in. thick precast concrete tiles.

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

Concluded from page 91

In this concluding article on the British Instrument Industries' Exhibition, we give descriptions of fluid control valves, a spectrometer amplifier, a cardiac catheterisation manometer, standardised instruments, apparatus for obtaining a representative sample of particulate mixtures, and a system of measuring strains in sheet materials by means of a Moiré technique. Certain other exhibits including several presented by the Ministry of Supply are also briefly outlined.

DIAPHRAGM VALVES

J. Blakeborough and Sons, Limited, Brighouse, Yorkshire, exhibited examples from their range of diaphragm-operated valves for automatic process-control applications. These are made under licence from the Hammel-Dahl Company, 243 Richmond-street, Providence, Rhode Island, U.S.A., and Fig. 12 shows a Hammel-Dahl diaphragm control valve of " Venturiflo " angle pattern.

This valve is in cast steel and incorporates a special seal-balanced " Holo " plug, which is designed to give the combined features of balanced control and tight shut-off in operation. Other items included a large cast-steel double-seated globe valve with stainless-steel trim; a butterfly valve with continuously connected handwheel for alternative manual operation; and various barstock valves fitted with either solid plug or spline plug to give accuracy in the control of small flows.

In addition were shown examples of the application of Dahl and bellows seals; the company's diaphragm motor; and a springless pre-loaded superstructure with duplex diaphragm, which provides the high power necessary for stable control and tight shut-off on heavily unbalanced single-seated valves with air-to-open action.

GAS AND OIL VALVES

Black Automatic Controls, Limited, 159 Moor-street, Birmingham, 4, commenced operations 18 months ago and were taking part in the British Instrument Industries' Exhibition for the first time. Among their exhibits were examples of solenoid valves of glandless construction suitable for gas, water, oil, steam and other fluids and including two-position and three-way valves; sub-miniature valves; diaphragm-operated pressure switches; and a range of thermostats for industrial applications, particularly in connection with combustion control.

The company's oil valves include both light and heavy duty designs for use with various kinds of oil burner, and hand-opening versions for use with heavy oil. A range of adjustable by-pass oil valves have been developed for service with burners of high and low flame pattern and are of three types: valves having variable minimum opening position set by means of a screwed top and lock nut; valves with stable calibrated adjustment of minimum opening position (in small sizes only); and metering valves with adjustment for both high and low flame settings.

The range of gas valves embraces sizes from ⅛ in. to 4 in. B.S.P. and is suitable for town gas, methane, propane, butane and similar penetrating gases in which a high degree of gas-tightness is required in the closed position.

With the exception of the small pilot valves, the gas valves are also made in a parallel range provided with adjustable by-passes for high and low flame working, while the shut-off valves can also be produced with an adjustable position switch. This safety feature gives electrical-contact closure when the valve is fully closed, thus permitting signalling or safety control arrangements to suit particular cases. Fig. 13 shows a Black type-LG/MS gas valve with safety switch.

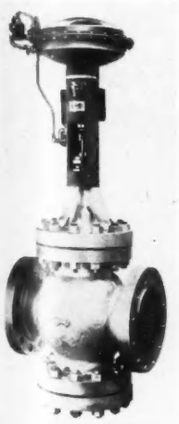


Fig. 12 The Hammel-Dahl " Venturiflo " angle-type diaphragm control valve is made in this country by J. Blakeborough and Sons, and incorporates a seal-balanced plug to give balanced control and tight shut-off.

CHEMICAL ANALYSIS AND PRESSURE MEASUREMENT

An improved form of spectrometer amplifier for use with photo-conductive and photo-voltaic cells, and the Mervyn-Green manometer designed primarily for cardiac catheterisation in heart surgery, but with other applications involving the indication and recording of fluctuating pressures, were two of the items displayed by Mervyn Instruments, Copse-road, St. John's, Woking, Surrey. Also shown were instruments in which electronic techniques were applied to chemical analysis, and among these were the Mervyn-N.P.L. infra-red spectrometer for gas and liquid analysis in chemical plants, and the Mervyn-Harwell square-wave polarograph.

This instrument, designed for the analysis of reducible metal ions, is unlike the conventional polarograph in that a square-wave voltage is applied to the cell, superimposed on the normal slowly changing direct-current voltage. This overcomes some of the disadvantages hitherto associated with the technique and permits a sensitivity which the makers claim is a hundred times that of the equipment used in classical polarography. In addition, it is convenient for the simultaneous determinations of mixtures of widely different concentrations, and it will deal with solutions in which the amounts of ions present are not directly related to their half-wave potentials.

The Mervyn-Green manometer has been built for use in conjunction with the surgical technique of cardiac catheterisation which enables information on blood pressure in the heart and associated organs to be obtained directly. The pressure-measuring element consists of a special transducer tube, the anode of which is driven from a diaphragm in contact with the fluid in the catheter. The output from the tube when the diaphragm is displaced by pressures developed in the catheter is fed to an amplifier. The unit has been developed in collaboration with the cardiac department of the Middlesex Hospital.

Fig. 13 Black Automatic Controls, Limited, make valves for use with gas, water, oil, steam and other fluids and for such applications as burner control. The gas valve shown here is fitted with a safety electrical-contact switch.

Fig. 14 shows the latest form of the Mervyn spectrometer amplifier, which has an overall gain exceeding 120 dB and has an input suitable for both photo-voltaic and photo-conductive cells. It can measure radiations from the ultra-violet to the infra-red. The complete unit consists of an 800-cycle tuned amplifier, a correlation detector, an output stage and a circuit providing the reference signal for the detector. Suitable power supplies are built into the instrument and a monitoring meter is displayed on the front panel together with the main output termination. The output is sufficient to drive a standard milliameter type of recorder.

STANDARD PRESENTATION

A new class of instruments known as the " Commander " range and a display showing the application of Kent automatic controllers and measuring instruments to processes in particular industries provided the basis of the exhibit of George Kent, Limited, Luton, Bedfordshire. Industries represented included those concerned with glass, gas, steel, water, sewage, chemicals, sugar, oil and steam power. The control of Wobbe index, feeder-level control for glass furnaces and feeder-glass temperature control, were examples from the glass industry; and catalytic-cracker airflow and circulating water measurement, and automatic oil-blending control

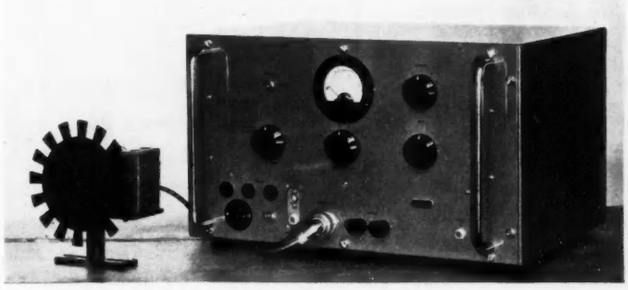


Fig. 14 The Mervyn spectrometer amplifier, which has an overall gain exceeding 120 dB and an input suitable for both photo-voltaic and photo-conductive cells, can measure radiation from the infra-red to the ultra-violet.

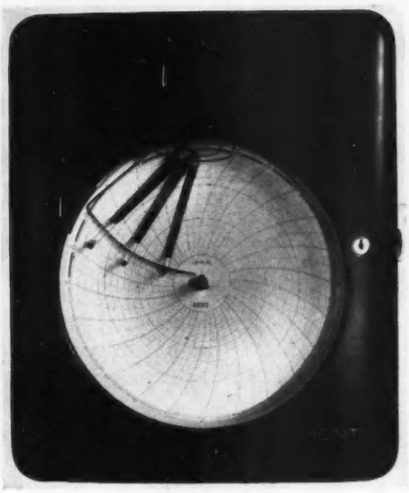


Fig. 15 Kent " Commander " class KP unit for recording three pressures simultaneously. Controlling and recording instruments in the Commander range have cases and many internal parts standardised in accordance with B.S. recommendations.

illustrated the use of instruments in the oil industry. Furnace temperature and combustion control in steel works, trade effluents, superheat temperature control and sulphur recovery were other fields covered.

The instrument shown in Fig. 15 is a Commander class KP unit for recording three pressures simultaneously and in form is typical of the new series. The Commander range includes both measuring and controlling instruments, and case design and many internal parts have been standardised in accordance with British Standards Institution recommendations. Such variables as flow, liquid level, specific gravity, pressure and temperature can be dealt with, and transmission and automatic control are other features within the scope of the range. Instruments with a number of combinations of presentation and controlling elements were on view, in addition to specialised instruments such as the Commander-class boiler test indicator and range receiver recorders.

The section of the exhibit illustrating industrial application of instruments included pneumatic computers, bleed units, injector units and automatically regulated power cylinders for the steel industry; the Kent universal glass electrode pH recorder, a model of the Dall tube, and an electrical flow transmitter working from an orifice for the water industry; and an oxygen controller for the gas industry.

PARTICLE SAMPLING

The Department of Scientific and Industrial Research is responsible for fourteen national research stations and also works in close co-operation with more than forty trade research associations. Many of these were represented on the D.S.I.R. stand at the exhibition. The instruments and other items shown included a recording smoke meter, a rapid grain-moisture meter, a ballistic discharge tachometer, a total-heat meter, a venturi pneumatic pyrometer based on density measurement, a cyclone steam and water separator, a machine for sharpening tungsten-steel microtome knives having cutting angles from 26 deg. to 32 deg., a shoe sole-adhesion tester, a catenary galvanometer for brittle-fracture research, and a device for rapidly determining the oil or grease content of worsted tops and similar materials. In addition were shown a Moiré technique for two-dimensional strain measurement and a grid-type two-way sample divider.

In order to divide a sample of particulate materials into a large number of parts and recombine them to give two samples, each representative of the whole, the Fuel Research Station, River-way, Blackwall-lane, East Greenwich, S.E.10, have developed the equipment which is shown in transparent model form in Fig. 16. The sample is poured on to a grid with square apertures. If these apertures are imagined to be marked in a chessboard pattern, the material falling through the " white " squares is collected by a set of tubes beneath them and led to a receiver; similarly the " black " squares lead to a second receiver. The process may be repeated as often as may be necessary to obtain a final sample of suitable size.

If desired, the grid can be constructed to divide the sample into three sub-samples instead of two. This principle may be adopted for sub-dividing small samples of powdered or granulated material in the laboratory, or for the sub-division of crushed material on a large scale. It may also be used for dividing an air-borne stream of particles into a number of smaller representative streams.

The information given here concerning the sample divider is Crown Copyright and reproduced by permission of the Controller, H.M. Stationery Office.

STRAIN MEASUREMENT BY MOIRÉ TECHNIQUE

It is often necessary to measure the strain arising when a sheet material is deformed in its own plane, and to estimate whether the distribution of the strain is uniform. It is possible to accomplish this by using the properties of superimposed patterns. Whether these patterns are natural ones (as in the weave of textiles) or artificially imposed as a printed half-tone, each will consist of a printed *motif* repeated over a basic framework called the " lattice " of the pattern.

A pattern has certain rotational and translational repetitive characteristics (the latter defining the lattice). The Moiré of two patterns is the pattern resulting from their superposition, photographically or otherwise, and likewise has repetitive features the dimensions of which may be calculated from the lattice dimensions of the original patterns. The Moiré dimensions are large if the two lattices are closely similar, making the Moiré a sensitive measure of small differences between them.

If one lattice is regarded as arising from the other by a homogeneous deformation, the Moiré dimensions can be directly related to the strain involved. When, for instance, a sheet material is deformed in its plane, any pattern on it must deform in the same manner and the strain between any two stages of the deformation can be derived from the Moiré of the two corresponding forms of the pattern. This pattern, as previously stated, may be a natural one, as with textiles, or it may be artificially imposed as a printed halftone.

The method has the advantage that the strain is derived from first-order measurements and not by difference. Also the complete strain tensor of homogeneous deformation in rectilinear co-ordinates is obtained, and the whole field of strain where the deformation is heterogeneous. Using screens of 85 dots per inch, components of strain from 0·01 to 0·1 have been measured to within 0·001. This accuracy can be improved by the use of a finer screen.

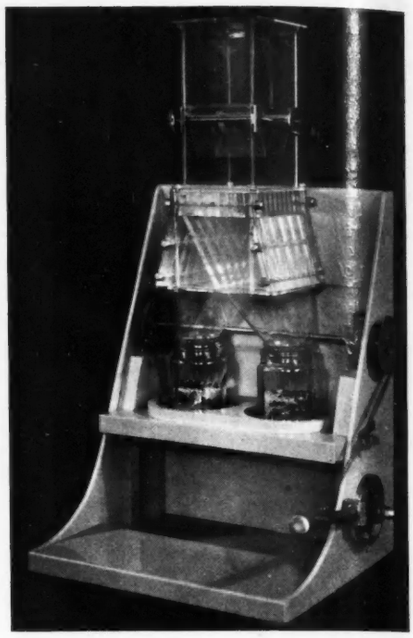


Fig. 16 Transparent model of apparatus developed by the Fuel Research Station for dividing a sample of particulate materials into a large number of parts and recombining them to give two samples, each representative of the whole.

Fig. 17 indicates the kind of pattern obtained with this method, and an exhibit illustrating the use of the technique was shown by the Printing, Packaging and Allied Trades Research Association, Patra House, Randalls-road, Leatherhead, Surrey.

OTHER EXHIBITS IN BRIEF

Ministry of Supply Exhibits.—The Marine Aircraft Experimental Establishment exhibited a miniature pressure transducer designed to measure water pressure in testing parachute drops of airborne lifeboats, and a recording accelerometer used in seaplane test work. The Aeroplane and Armament Experimental Establishment demonstrated an instrument for recording and analysing noxious gases which might accumulate in the gun bays of aircraft during tests, and showed an instrument for recording the rate of gunfire. A moving-magnet electrical indicating instrument suitable for use as a remote position

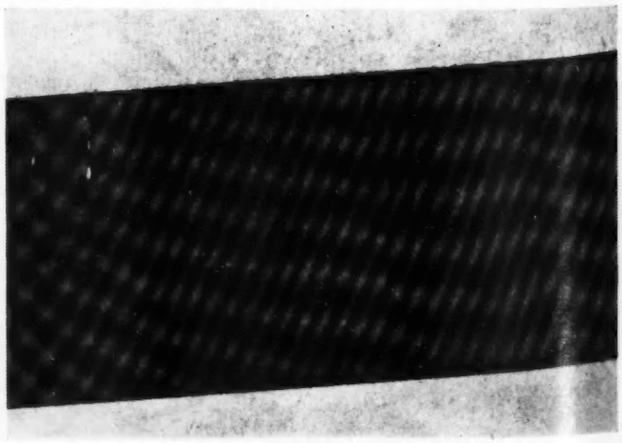


Fig. 17 Strains in sheet materials can be investigated by means of a Moiré technique developed by the Printing, Packaging and Allied Trades Association.

indicator; an air-leakage indicator for measuring leakage rates through sealed air-filled electronics components; and a capacitance comparator were displayed by the Royal Aircraft Establishment; and the Signals Research and Development Establishment showed a recording torque meter and a barium-titanate accelerometer with built-in cathode tube for recording the impacts and vibration received by a radio component. Among items exhibited by the Radar Research Establishment was an aerial phase and altitude plotter used to measure quickly and simultaneously the phase and amplitude characteristics of an aerial under test, and a wattmeter for measuring the noise factor of receivers.

Check Weigher.—The Solartron check weigher has been developed to cope with the weighing of commodity packages where thousands are produced daily, and is designed to limit wastage due to unnecessarily large excess margins. Its makers claim for it a constant accuracy of 0·1 per cent. with a pre-set weight for reference, and it is capable of checking items up to 10 lb. at rates as high as 120 per minute. A contact output for indicating underweight loading, and a separate time integrated output for control of associated dispensing machinery may be employed. The same company exhibited a high-frequency synchronously energised motor for extra-high-speed grinding. (The Solartron Electronic Group Limited, Thames Ditton, Surrey)

Smoke and Fire Detector.—Protecting the stand of Electronic Instruments Limited was the "Minerva" smoke detector. Smoke or fumes distub the passage of alpha rays emitted by a radioactive source, and the instrument immediately sounds an alarm. (Minerva Detectors Limited, Richmond, Surrey)

Automatic Laboratory.—Sequence control units metering and mixing units, analysing units and recording units form the basis of the "Analmatic" automatic laboratories, which are designed to perform routine analyses without attention. (Baird and Tatlock (London), Limited, Chadwell Heath, Essex)

Wine Tester.—Percentage alcohol content can be tested by a simple instrument consisting of a graduated capillary tube with a cup or funnel at one end. When the capillary tube has been filled with liquid by means of the cup, the tester is inverted and stood on a dry table top. The liquid runs down the graduated tube and the point at which its upper surface comes to rest is an indication of its percentage alcohol content. (H. J. Elliott, Limited, Trefcrest, Glamorgan)

KEYSEATING AND INTERNAL PROFILE CUTTING

HYDRAULIC AND MECHANICAL MACHINES

The Frömag keyseating machine, which is made by Fröndenberger Maschinen- und Apparatebau G.m.b.H., Fröndenberg, Germany, and distributed in the United Kingdom by the Mortimer Engineering Company, 210 Acton-lane, Harlesden, London, N.W.10, is available in two sizes, the larger being hydraulic and the smaller mechanical. Both machines are similar in principle, the component being clamped between two centring bushes while a keyseating or profile tool is reciprocated in the bore, the tool being guided by a vertical cutter bar. Feed is applied by a wedge at the back of the tool, which is drawn down at the top of each stroke to give the cutting increment required. At the bottom of the stroke the feed-wedge is raised slightly, and it remains in this position during the whole of the upward stroke to relieve the tool from the work. The centring bushes and cutter bar project from the top of the machine, and large-diameter or oddly-shaped components can be set in position and removed without difficulty.

The Frömag keyseater, shown here in the larger, hydraulic version, will cut a variety of internal profiles as well as keyways.

The larger machine will cut keyways from $\frac{1}{8}$ in. to $3\frac{1}{2}$ in. wide in bores from $\frac{1}{2}$ in. to $17\frac{3}{8}$ in. diameter. It is available in two versions, both having the same keyway width and bore range, but one version has a stroke which is adjustable from 3 in. to $18\frac{3}{4}$ in., while in the other the stroke can be varied from 3 in. to $24\frac{1}{2}$ in. The machine is driven by an electric motor of approximately $5\frac{1}{2}$ h.p., running at 1,420 r.p.m., coupled to a gear-type hydraulic pump. Means are provided for regulating the cutting power between 0·2 and 6 tons, and for adjusting the cutting speed from 3·3 ft. to 33 ft. per minute. The return speed of the cutting tool is twice that of cutting. Controls are centralised on a panel at the front of the machine.

SMALLER MECHANICAL MACHINE

On the smaller model of the keyseater the stroke is adjustable from 3 in. to $9\frac{7}{8}$ in., and a range of keyways from $\frac{1}{8}$ in. to $1\frac{1}{4}$ in. wide can be cut. The bore sizes which the machine will handle range from $\frac{1}{2}$ in. to $11\frac{3}{4}$ in. The drive is from a $2\frac{1}{4}$-h.p. motor, through a V-belt and worm gear, with an adjustable crank on the worm wheel. The V-belt pulleys have three steps, giving working speeds of 50 strokes per minute for a stroke of 4 in., 32 per minute for a stroke of 7 in., and 20 for the maximum length of stroke. These stroke rates correspond to an average cutting speed of 33 ft. per minute.

In both machines a chip-tray is provided round the cutter-bar, to discharge swarf into a container at the front of the machine. An additional receptacle is arranged in the machine base, to catch any swarf not discharged by the chip-tray. Both containers are easily removed for emptying. Either machine can be used for forming internal profiles such as splines, serrations, tangential keyways or tapered keyways by means of special attachments which can be supplied as extras. In addition they can be used for broaching, the maximum cutting pull on the larger machine being 6 tons, and that on the smaller 4,400 lb.

Different sizes of boxes or trays can be formed by selecting the appropriate finger segments in this new box-folding machine.

BOX FOLDING MACHINE

Another machine for folding sheet into trays or boxes has been added to the "Besco" range of F. J. Edwards, Limited, 359-361 Euston-road, London, N.W.1. It is available in three sizes with widths of 48 in., 72 in. and 96 in. Hand operated, they will bend 14 s.w.g. steel to form trays with a maximum depth of $8\frac{3}{4}$ in. The 72-in. model is illustrated above.

To obtain the various sizes of box or tray the blade is made up of segments of various widths which can be assembled to give the required size. The 48-in. machine for example, has four 3-in., four 4-in. and four 5-in. segments and the 96-in. model has five of each of these sizes and six 6-in. segments in addition. All the segments have 1 in. clearance underneath.

The folding axis is adjustable in height, and the folding beam itself can also be similarly adjusted. When these two adjustments are used in conjunction with each other and special-radius nose fingers or blades are used in place of the sharp type fitted, true radius bends and folds are possible up to 1 in. Should radius bends be required which are shorter than the full bending length, simple radius blades can be clamped in position under the fingers at the ends of the blade. In this way, small trunks can also be formed round the special folding bar and removed with the bar, but the capacity of the machine will be reduced. The clamping beam has a lift of $2\frac{1}{4}$ in. from the bed, and the minimum angle of bend formed is 45 deg.

The amount of adjustment made in the side arms is indicated by scales, graduated in sixteenths, at each end of the machine. When an adjustment is made to the folding axis, the same adjustment must be made to the folding beam, but in the opposite direction. Thus, should the folding centres be raised to the required radius, the folding beam must be lowered the same amount, plus the thickness of the material.

Heavy adjustable weights set on long arms counter-balance the folding beam at each end and assist the manual pull-up. An aid for use in repetition bending is an adjustable stop which controls the amount of travel of the beam. When narrow reverse bends are required, the detachable angle bar on the edge of the folding beam should be removed, leaving an edge of $\frac{5}{8}$ in. wide. A minimum return bend of $\frac{3}{8}$ in. wide in light gauge sheet can be obtained by removing the auxiliary blade lying behind the angle bar.

* * *

INDEX TO "ENGINEERING"

Volume 178 now ready

The Index to Volume 178 (July-December. 1954) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher, 35 and 36, Bedford-street, London, W.C.2. Any reader wishing to receive regular copies of the Index as they are published can apply to be put on the mailing list. Those already on the list need not re-apply.

LATHE DRIVING DOG

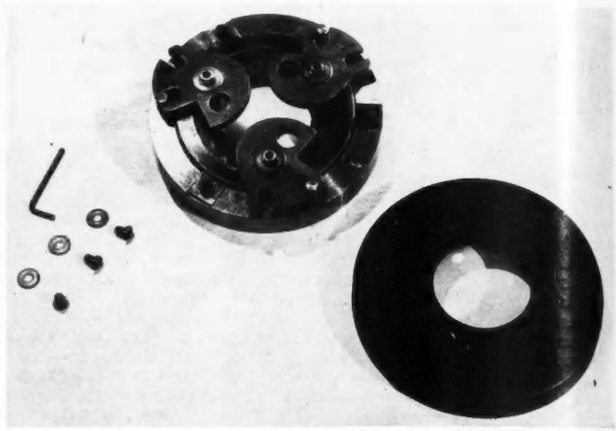
Work up to 5¼-in. in Diameter between Centres

An automatic driving dog has been added to the range of products made by F. Pratt and Company, Limited, Lister-lane, Halifax. Called the "Auto-Grip" work driver, it has a large range of capacity and can take rough or smooth material. The mechanism, with the cover plate removed, is illustrated on the right.

Basically the driving dog consists of an outer body with an inner floating ring which is under the constraint of two springs and on which the pivots for the driving dogs are mounted. The outer body is bolted to the faceplate of the lathe, using an adaptor plate. The live centre protrudes through the faceplate and partway through the body. Thus, when the drive commences, the outer body moves slightly in relation to the floating ring and the pins on it cause a slight rotation of the driving dogs. As the serrated driving faces of these are eccentric to the pivots, they grip the workpiece firmly; the greater the resistance to rotation, the greater the grip applied. The constraining springs hold the dogs against the work when the lathe is not driving. It is possible to arrange for a drive in either direction by reversing the dogs and springs.

To load the workpiece, the outer cover and ring are rotated in the direction of the drive until the jaws are fully open. The workpiece is then inserted between centres and the outer cover turned in the reverse direction to allow the spring-loaded jaws to grip the workpiece. A final twist of the latter against the direction of drive ensures that the jaws are fully and evenly engaged. Variation in the size is obtainable by using the alternative indexing position, so that with only three sets of jaws it is possible to handle work from ¾ in. in diameter to 5¼ in. in diameter when using the largest of the four models.

As the three jaws are equally spaced an even drive is obtained even when out-of-round workpieces are being handled. One very advantageous feature is that the exterior is smooth and free from all projections likely to catch in clothing or hands. The dog can be used for all types of centre turning work.

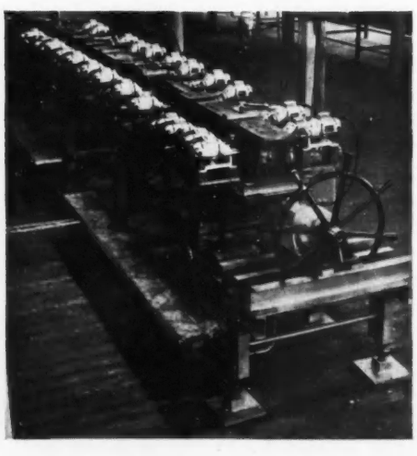


The three jaws of the "Auto-Grip" lathe dog give an even drive on both smooth and rough or out-of-round workpieces.

* * *

A SIMPLE LAYOUT FOR CHASSIS DRILLING

The illustration below shows a simple arrangement for drilling commercial vehicle frames which has been designed by Seddon Diesel Vehicles, Limited, Oldham, in conjunction with Black and Decker, Limited, Harmondsworth, Middlesex. It consists of a steel framework with a jig in which two frame members can be mounted back-to-back, and six laterally-sliding carriages carrying Black and Decker ⅜ in. heavy-duty electric drills. Two further drills, of ½ in. capacity are mounted on vertical stands with sliding arms on the right-hand side of the drill-jig. In all, 42 drills have been used; those on the sliding carriages are modified by the removal of the side handles and switches and the fitting of junction-boxes so that they can be controlled simultaneously by master switches.



Forty-two portable electric drills are used in this chassis drilling rig designed and used by Seddon Diesel Vehicles Limited.

The sliding carriages are equipped with racks engaging with pinions on a central shaft, which is rotated, through a 4 to 1 reduction gear, by a hand capstan wheel. To drill a pair of frames the operator switches on the left-hand bank of drills and turns the capstan wheel in a clockwise direction. All the left-hand carriages then move forward, and this movement is continued until the drilling on the side is complete. The wheel is then rotated in an anti-clockwise direction, which causes the left-hand bank of drills to be retracted, and the right-hand one to come into the drilling position. Master switches control the two banks of drills, only that bank which is in use being under power. The drills are inserted in the chucks at varying positions, so that they do not all start drilling simultaneously. When the side holes have been drilled the vertical sliding-arm mounted drills are brought into use to drill a number of holes in the frame flanges. Finally, the frames are removed, and all the holes are de-burred by means of a countersink mounted in a standard Black and Decker portable ¼-in. drill.

* * *

LUMINANCE OF FLUORESCENT POWDERS

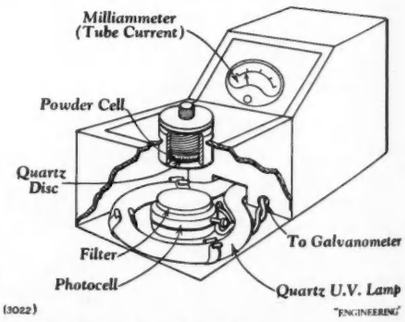
To measure the luminance of experimental and production fluorescent powders under a given amount of radiation the Research Laboratories of the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, have developed a simple photometer, shown diagrammatically in the illustration on the right.

It consists essentially of a cubical box with a totally black inner surface and a small circular hole in the centre of a hinged lid. Short-wave ultra-violet radiation is provided by a low-pressure mercury-vapour discharge in a quartz tube. This tube is bent into a circular shape round a photo-cell. The photo-cell is of the rectifier type and is covered by a filter which gives it an approximate "average eye" response. The tube and photo-cell unit are mounted in the base of the box with their centres below the lid aperture. This ensures that no direct light from the ultra-violet tube falls on the photo-cell.

One of the main problems in comparing the luminances of different phosphors is to obtain a standard fluorescing surface. This has been solved by designing a standard circular glass box or "cell" which holds about 5 gm. of the phosphor. When the lid of the cell is screwed down, the powder is compressed into a layer 1–2 mm. thick, and a uniform and repeatable surface is obtained on the transparent window in the base of the cell.

For rapid comparison of luminances, two such cells are used, both having crystal quartz windows. One cell is filled with the powder under test and the other with a standard material. This is a phosphor which is of the same colour, type and general composition as that under test. The test procedure is to place first the cell containing the standard, and then the cell containing new powder into the upper hole in the photometer. The ultra-violet radiation which reaches the window of each cell causes the powder to fluoresce. As the fluorescent light falls on the photo-cell, the different currents produced, which are dependent on the luminance of the phosphor layer, are read off on a galvanometer.

A small quantity of visible light is also emitted by the ultra-violet lamp and reflected from the surface of the phosphor. To allow for this light in assessing the relative luminances of the phosphors, a third cell, also containing the standard phosphor but having a window made of glass, is now introduced. The glass prevents ultra-violet radiation reaching the phosphor so that only reflected visible radiation from an ultra-violet lamp reaches the photo-cell. This component can then be subtracted from the figures previously obtained, giving the required ratio of sample to standard fluorescence only.

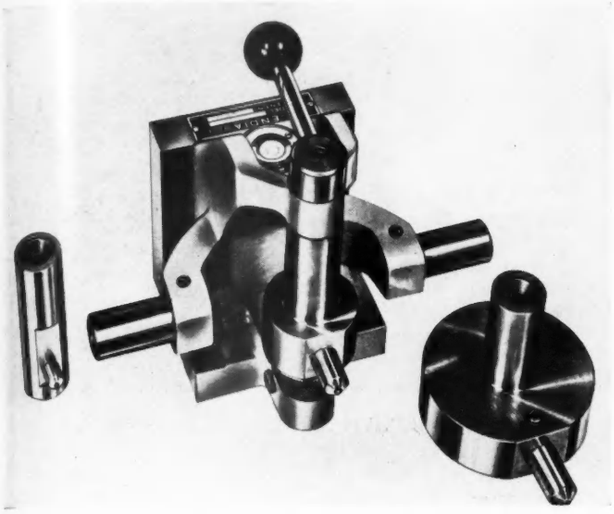


This instrument has been developed to measure the luminance of fluorescent powders.

* * *

RUBBER MATTING

A new rubber matting for factory operatives to stand on is announced from Dunlop's general rubber goods division, Cambridge-street, Manchester. The matting is in a raised cube pattern to reduce the danger of slipping. Other advantages claimed are its resilience, which will reduce the fatigue of standing; its absorption of noise; and its protection of the worker from chills. It can be supplied in synthetic rubber, with its better resistance to the effects of oil, for factories where oil spillage is likely to occur.



The "Endia" radius fixture has three interchangeable mandrels, enabling concave radii from ½ in. to 3 in. to be produced on any grinding wheel.

FORMING CONCAVE RADII ON GRINDING WHEELS

An addition to the "Endia" range of radius fixtures made by Engineering Diamonds, Limited, 26 Warwick-row, Coventry, is illustrated herewith. The fixture has three interchangeable mandrels with capacities of ½ in. to $\frac{11}{16}$ in., $\frac{11}{16}$ in. to 1½ in., and 1½ in. to 3 in., respectively, and will form concave radii on wheels of any size.

The mandrels, which are hardened and ground, are mounted between hardened centres, and will swing the diamond through 180 deg. Each mandrel has a datum face to enable the diamond to be set to the required radius by slip gauge. The cast-iron base of the fixture is designed for use either vertically or horizontally, and a pair of removable bar extensions is provided for use between centres on a cylindrical grinding machine. A spirit level is built into the base casting to facilitate alignment of the diamond tool assembly with the centre of the grinding wheel.

MATERIAL HANDLING EQUIPMENT

Facilities for the Potential User

Mechanical handling of materials has spread to so many industries, and has developed to such an extent, that close co-operation between user and designer from the very early stages of a project has become essential. To provide the fullest possible facilities for this co-operation, Fisher and Ludlow, Limited, Material Handling Division, Bordesley Works, Birmingham, 12, have opened a Conveyor Development Centre where any conveying or handling problem can be discussed, designs can be prepared, and experimental layouts can be built. In addition the Centre has a large space devoted to demonstration, and a wide selection of standard equipment, under power and normal working conditions, is installed.

The Centre is at the Company's main works at Kingsbury-road, Erdington, Birmingham, 24. It is equipped with a conference room, drawing office, experimental workshop and a large demonstration area where the standard equipment is installed. The basic idea of the Centre is that a prospective user of the Company's handling equipment can visit it and, as a first step, discuss his problem with the design staff. The conference room provided for this purpose is large and well-lighted, and has ample facilities for the examination of drawings. As a result of the preliminary discussion it may appear that the particular problem can be solved by one or other of the Company's standard lines. If this is so, the piece of equipment in question can be seen under working conditions in the adjoining demonstration area. Alternatively, it may be decided that some small modification to a standard item is required. It may, for example, be necessary to make a special component carrier to fit on a standard conveyor, or to modify a conveyor, elevator or other item of handling equipment. The necessary drawings are then prepared in the drawing office attached to the Centre, the new parts are made or the equipment modified in the experimental workshop, and the idea is ready to be tested in the demonstration area. The whole process of solving a potential user's handling problems, from the initial discussion, through development to the final demonstration under power can therefore be carried out in one building, the Centre being entirely self-contained, drawing only its supply of standard components and raw materials from the factory.

The demonstration area, besides providing facilities for development and testing of ideas and new equipment, is available at all times to show the large range of handling and storage methods now available. The equipment on display includes 17 different conveyors, with a total length of over 600 ft.; about 150 pallets of many different types; over 50 storage units; 1,000 square ft. of platforming; 3,250 sq. ft. of partitioning and 2,000 ft. of "Flowstrut" slotted angle, the latter being put to practical use in the support of various conveyors.

* * *

LAUNCHES AND TRIAL TRIPS

M.S. "Spervik."—Single-screw oil tanker, built and engined by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, for Skips A/S Spervik, Sandefjord, Norway. Main dimensions: 510 ft. by 69 ft. by 37 ft.; deadweight capacity, about 17,250 tons. Scott-Doxford opposed-piston oil engine, developing about 5,500 b.h.p. Launch, June 20.

M.S. "St. Hilda."—Single-screw trawler, built by Richard Dunston, Ltd., Hessle, near Hull, for the Friarage Steam Fishing Co., Ltd., Hartlepool. Main dimensions: 100 ft. by 22 ft. by 10 ft. 9 in.; fishroom capacity, 5,540 cub. ft. Oil engine, developing about 400 b.h.p., constructed by Crossley Brothers, Ltd., Openshaw, Manchester. Trial trip, June 22.

M.S. "Dagali"—Single-screw oil tanker, built and engined by Burmeister and Wain, Ltd., Copenhagen, Denmark, for John P. Pedersen and Son, Oslo, Norway. Main dimensions: 545 ft. between perpendiculars by 70 ft. 6 in. by 39 ft. to main deck; deadweight capacity, 18,250 tons on a summer draught of about 29 ft. 6 in.; oil-tank capacity, about 25,760 cub. metres. B. and W. six-cylinder single-acting two-stroke oil engine, developing 7,500 b.h.p. at 115 r.p.m. Main engine arranged for burning either Diesel fuel or heavy oil. Speed, 15 knots fully loaded. Trial trip, June 23.

M.S. "Vigrafjord."—Single-screw cargo vessel, built by Short Brothers, Ltd., Sunderland, for Skibs A/S Malmtransport, Oslo, Norway. Main dimensions: 450 ft. between perpendiculars by 61 ft. by 38 ft. 8 in.; deadweight capacity, about 10,200 tons on a draught of 26 ft. 7½ in. Kincaid-Harland and Wolff-Burmeister and Wain five-cylinder two-stroke opposed-piston oil engine, developing 5,500 b.h.p. at about 112 r.p.m. in service, constructed by John G. Kincaid & Co., Ltd., Greenock. Trial trip, June 29.

M.S. "Nike."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, for the Rederiaktiebolaget Transoil (one of the Sörman group of companies), Gothenburg, Sweden. Third of a series of oil tankers built for these owners. Main dimensions: 593 ft. 6 in. overall by 74 ft. 6 in. by 42 ft. 3 in.; deadweight capacity, 23,600 tons on a summer draught of 32 ft. 4 in.; oil-cargo capacity, 1,080,000 cub. ft. Götaverken nine-cylinder single-acting two-stroke heavy-oil engine, developing 10,000 i.h.p. at 112 r.p.m. Service speed, 15 knots fully loaded. Delivered, June 30.

M.S. "Border Laird."—Single-screw oil tanker, built by Lithgows, Ltd., Port Glasgow, for the Lowland Tanker Co., Ltd. (Managers: Common Brothers Ltd.), Newcastle-upon-Tyne. Main dimensions: 515 ft. between perpendiculars by 69 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, about 16,000 tons. Fairfield-Doxford six-cylinder opposed-piston oil engine, developing about 6,800 b.h.p., constructed by the Fairfield Shipbuilding and Engineering Co., Ltd., Glasgow. Speed, about 15 knots fully loaded. Launch, June 30.

M.S. "Ivan Gorthon."—Single-screw cargo vessel, built by Öresundsvarvet A/B, Landskrona, Sweden, to the order of the Rederi A/B Gylfe (Managers: Stig Gorthon), Helsingborg, Sweden, for the carriage of paper pulp between Canadian and Swedish and United Kingdom ports. Main dimensions: 315 ft. by 43 ft. 8 in. by 27 ft. 7 in.; deadweight capacity, about 3,515 tons. Six-cylinder oil engine, developing 2,250 b.h.p., constructed by the Götaverken Shipyard, Gothenburg, Sweden. Speed, about 13 knots. Trial trip, June 30.

S.S. "Harpula."—Single-screw oil tanker, built and engined by Harland & Wolff, Ltd., Belfast, for Shell Tankers Ltd. (Marine Managers for the Anglo-Saxon Petroleum Co., Ltd.), London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft. to upper deck; deadweight capacity, about 18,000 tons. Single-shaft arrangement of double-reduction geared steam turbines developing a total of 7,500 s.h.p. in service. Steam supplied by two Babcock and Wilcox oil-fired water-tube boilers. Launch, July 6.

M.S. "Port Melbourne."—Twin-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Belfast, for the Port Line Ltd., London, E.C.3. Main dimensions: 498 ft. between perpendiculars by 70 ft. by 42 ft. to upper deck; gross tonnage, about 10,470. Two Harland-B. and W. six-cylinder single-acting two-stroke opposed-piston oil engines, arranged to burn heavy fuel, with Diesel oil as an alternative. Trial trip, July 6.

M.S. "Red Hackle."—Single-screw trawler, built by John Lewis and Sons, Ltd., Aberdeen, for the Iago Steam Trawler Co., Ltd., Fleetwood, Lancashire. Main dimensions: 135 ft. between perpendiculars by 26 ft. 6 in. by 13 ft. 3 in.; fishroom capacity, about 9,300 cub. ft. Five-cylinder Diesel engine, developing 800 b.h.p. at 250 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Launch, July 7.

M.S. "Pharos."—Twin-screw lighthouse tender, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Commissioners of Northern Lighthouses, Edinburgh. Main dimensions: 235 ft. between perpendiculars by 40 ft. by 19 ft. 6 in.; service draught, 13 ft. Two seven-cylinder single-acting two-stroke marine Diesel engines, each developing 985 b.h.p. at 220 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Speed, 14 knots. Trial trip, July 12.

H.M.S. "Shipham."—Inshore minesweeper, built by Brooke Marine, Ltd., Lowestoft. Ninth inshore minesweeper built by this firm during the past two years. These vessels have a length of 106 ft. 5 in.; a breadth of 20 ft. 6 in.; are of all-wood construction, and are designed to operate in shallow waters. Launch, July 14.

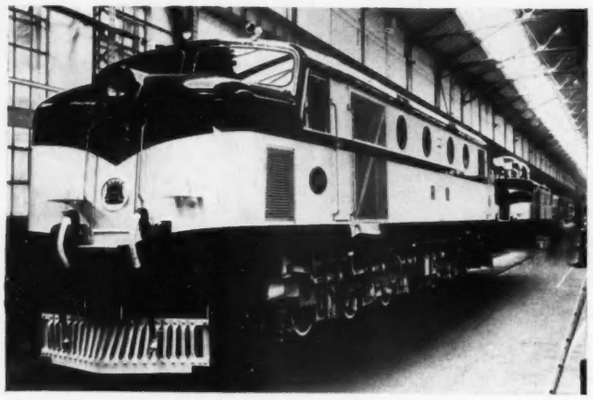


Fig. 1 Narrow-gauge Diesel-electric locomotive for the Rhodesia Railways.

Fig. 2 3,600-h.p. 3,000-volt D.C. electric locomotive for the Spanish National Railways.

ELECTRIC AND DIESEL-ELECTRIC TRACTION FOR MAIN-LINE RAILWAYS

ENGLISH ELECTRIC COMPANY'S CONTRIBUTION TO RAILWAY ECONOMY

Although, so far, only a comparatively small number of electric and Diesel-electric locomotives have been employed on the main-line railways of this country, British engineers have made an important contribution to the development of this form of traction on overseas lines within the Commonwealth and in several foreign countries. They have thus acquired valuable experience in meeting the varied and often difficult operating conditions encountered in many parts of the world and have been able to build up an extensive export trade. Since the end of the second World War one British organisation alone, the English Electric Company, Limited, has received orders for over a million horse-power of traction equipment for home and overseas railways, mostly, of course, for the latter.

These circumstances have long been familiar to engineers, but a wider interest in efficient railway operation has been in evidence in this country since the Minister of Transport announced his proposals for the modernisation of British Railways by the utilisation of electric and Diesel-electric traction. On July 8, to encourage this interest and to show how the company's activities in the field of electric traction are being applied to meet the requirements of British and overseas railways for efficient motive power, a large number of guests were shown over the Dick Kerr works at Preston, Lancashire, where some scores of locomotives were seen in various stages of construction in one of the locomotive-erecting bays, which are about 900 ft. in length. Work in the electric-traction field has been carried on at Preston for over 50 years and the Canberra aircraft is also built there, but other traction work is also handled at the Vulcan Foundry works, Newton-le-Willows, the Robert Stephenson and Hawthorns works, at Newcastle-upon-Tyne and Darlington, the Phoenix Dynamo works at Bradford (design and development) and the Willans Works at Rugby. The organisation, it may be noted, is able to construct complete electric and Diesel-electric locomotives at the Preston works and can also undertake entire electrification schemes, including the provision of power stations, sub-stations, overhead lines and rolling stock.

Among the work in progress at Preston at the time of the visit was the electrical equipment for Diesel-electric locomotives for South Australia, Nigeria, the Gold Coast and New Zealand, but the mechanical parts of some of these engines are being made at the Vulcan Foundry and at the Robert Stephenson and Hawthorns works. The South Australian locomotives are being built at the English Electric Company's works in Australia. For British Railways, Diesel engines, traction motors and control gear for the 400-h.p. Diesel-electric shunting locomotives, of which well over 300 are in service, were being constructed, as well as traction motors and control gear for the multiple-unit stock on the Southern Region; over 1,000 sets of motor-coach equipment have been supplied by the firm.

Fig. 3 2,000-h.p. 16-cylinder V-type Diesel-engine and generator in the Preston Works.

A particularly interesting Diesel-electric locomotive, of which the company is building 23 for use on the Salisbury and Umtali section of the Rhodesia Railways, was shown in a practically complete state. It is powered by a 16-cylinder V-type supercharged Diesel engine developing 2,000 h.p. at 850 r.p.m. and is understood to be the most powerful single-unit Diesel-electric locomotive yet built for a narrow gauge (3 ft. 6 in.) railway. The locomotive, illustrated in Fig. 1, has a 1Co-Co1 wheel arrangement and is carried on two cast-steel bogies, each having three driving axles guided at the outer end by a Bissel truck. Fig. 3 shows the Diesel engine and generator ready for installation in a similar locomotive in the Preston shops. The order for these locomotives was received towards the end of 1952; some have already been delivered and officially accepted as recently as June 22 last and others are in transit. The weight of the locomotive in running order is 113 tons and the length over the buffer beams is 56 ft.

Also seen in course of construction at Preston was the electrical equipment for some of the 3,600-h.p. 3,000-volt direct-current electric locomotives, 60 of which have been ordered by the Red Nacional de los Ferrocarriles Españoles (RENFE). Some of these locomotives, which are the most powerful of their type yet constructed in this country, have been completed and are already in service; one is illustrated in Fig. 2. The mechanical parts of the locomotives are being built by the Vulcan Foundry Limited. The locomotives are for the 5 ft. 6 in. gauge of the Spanish railways, and the weight of each in running order is 118 tons. This is carried on two six-wheeled bogies with traction motors, each having a one-hour rating of 600 h.p., driving the axles through gearing, the ratio of which is 63 : 16. The locomotives are 67 ft. 9¼ in. in length over the buffers, and the wheelbase of the bogies is 15 ft. 9 in.; the distance between the king pins of the bogies is 34 ft. 10 in. The maximum permissible speed is 68·3 miles per hour and the tractive effort is 30,360 lb. at 36 miles per hour continuous rating. The locomotives are intended for working freight and passenger trains on the Oviedo-Leon-Ponferrada section of the former Northern Railway, this section serving an important industrial area and carrying heavy mineral traffic. Compressed air and regenerative braking is provided, with vacuum braking on the train.

The few items mentioned above by no means cover the whole of the work now passing through the Preston shops, but the total production of these works, together with that of the other branches of the organisation previously referred to, obviously constitutes an important contribution to the efforts which the British engineering industry is making to supply home and overseas railways with the efficient traction material they need for economical operation in face of high fuel costs and shortages and the competition with other forms of transport.

EFFECTING ECONOMIES IN CIVIL ENGINEERING DESIGNS

WORK OF THE BUILDING RESEARCH STATION

The Building Research Station, of the Department of Scientific and Industrial Research at Garston, near Watford, Hertfordshire, was open to visitors on Monday and Tuesday, July 18 and 19. Although the problems considered at the Station relate to many fields of the building industry, the display during the open days—the first to be held there—concentrated on the engineering problems that have and are being tackled. Emphasis was placed upon the direct value of such research in both the design office and in the field, and in showing how the information patiently accumulated at the Station was being absorbed into British Standards and Codes of Practice. The following report has been extracted from the excellent brochure that was given to visitors to assist in their tour of the Station.

Two Divisions were open for inspection, those of Engineering and Soil Mechanics. The main concern of the Engineering Division has been the study of the properties and use of materials of construction, particularly concrete and reinforced concrete, brick and steel; and the design and performance of structures. As concrete is so important in all fields of construction it has naturally received special consideration. The design of concrete mixes, quality control, finish and durability, have been extensively studied. The knowledge derived from researches on the basic properties of concrete such as shrinkage and creep, and its bond with reinforcement has been invaluable in the preparation of Codes of Practice. Researches on steelwork have been directed towards economy in steel-frame construction, and the current study of the stiffening of frames imparted by floors and walls, and on the strengthening of individual members of the framework by the material encasing them, calls for special mention.

The Soil Mechanics Division has done pioneer work in the development of a new branch of civil engineering in this country. Its work involves the study of soil behaviour in relation to a wide range of problems in building and civil engineering. The problems include the design of foundations for all kinds of structures, earth pressures on retaining walls and tunnels, and the stability of earthworks including earth dams. Laboratory studies of the properties of soils serve as a background to field investigations involving observations on full-scale structures in the field.

In presenting the work of these two Divisions, special emphasis has been given to lines of research which have an important bearing on structural design. They are: reinforced and prestressed concrete, load-bearing walls, steel-framed buildings, bridge-deck systems and foundation problems.

REINFORCED CONCRETE

Research into the properties of concrete and reinforced concrete has always formed an important part of the work of the Station, and considerable effort has been devoted to securing the application of the results of such research, particularly through Codes of Practice. In 1931, a request was received from the London County Council for recommendations for a Code of Practice for the use of reinforced concrete in buildings. Such recommendations were prepared by the Reinforced Concrete Structures Committee of the Building Research Board and were issued in 1934; and these recommendations, now commonly referred to as the D.S.I.R. Code, have remained the basis of other codes which have followed.

The 1934 Code embraced much of the information gained from the earlier researches at the Station, in which basic studies had been made of the structural interaction between concrete and its reinforcement, but it became clear during its preparation that there were many problems still requiring investigation. A co-operative investigation with the Reinforced Concrete Association was therefore undertaken, in which studies were made of the behaviour of short and long columns, beams and small frames. Fundamental data were obtained on the re-distribution of stresses and moments that occur at incipient failure at any part of a reinforced-concrete structure and of the increased strength that resulted from such redistribution.

In recent years there has been an increasing tendency for structural engineers to consider a new approach to design, and the work of the Station on reinforced concrete in particular has shown the need for this. It has become increasingly evident that the actual stresses in reinforced-concrete structures are often very different from those assumed in design; they are liable to considerable fluctuation as a result of shrinkage and creep of the concrete, and bear no direct relationship to the margin of safety of the structure against failure. It seems desirable, therefore, to get away from design methods based on checks that the calculated stresses throughout a structure are less than certain permissible values, and to introduce a new design philosophy of which the main principles are: (i) that the load which will just cause failure of the structure is sufficiently greater than the working load, so that the probability of failure during the required life of the structure is less than a specified limit; (ii) that, for working-load conditions throughout the required life, the deformations of the structure shall not be such as to impair its safety or efficiency; and (iii) that economic considerations in the design of structures shall include full allowance for the need for, and cost of, maintenance during the life of the structure.

With regard to the first principle, the ratio of the load that will first cause failure to the working load is now commonly referred to as the "load factor against failure" and the design procedure as a whole may be called a load-factor method of design. Much research is still required to provide data that will enable designers to use this new method of design with safety and economy. Research at present in hand concerns the strengths of reinforced-concrete walls, shell roofs and slender beams; and the value of compression reinforcement in beams.

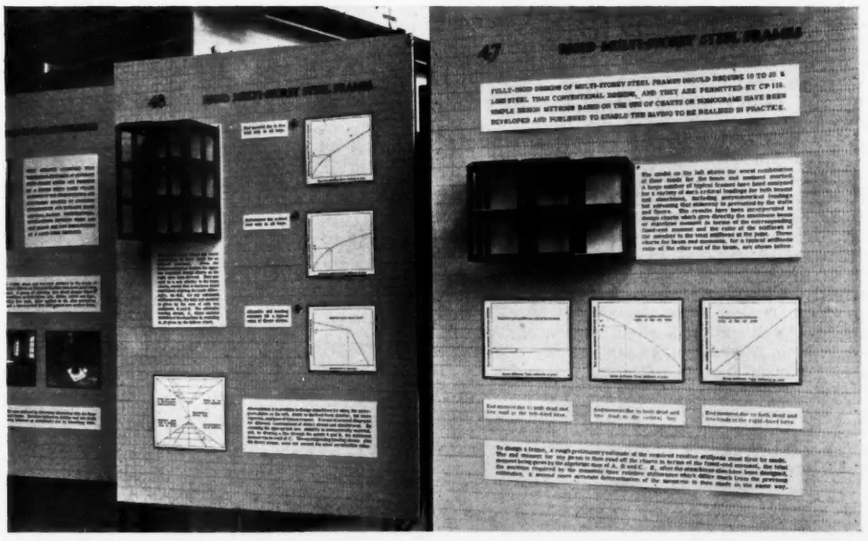
The load-factor method of design, in its most general form, must allow for the variability of all the factors which affect the balance between the strength of the structure and the loads it supports. One important feature of this is the quality of the concrete used in constructural work and the degree of its control. This is a subject which has been given considerable attention by the Station over a period of many years and an attempt has been made to introduce in the draft revision of the Code a more rational approach to concrete-mix design than that of resorting to "nominal mixes" as in the past. Although it may be necessary to retain nominal mixes for some years yet in building work, it is hoped that the new provisions in the Code for designing concrete to give the strength and workability required will be widely used. Understanding and acceptance of the methods proposed can effect immediate economies since, for example, many local aggregates which give relatively unsatisfactory results when used in a "nominal mix" can be made to produce high-quality concrete if the mix is properly designed.

STEEL-FRAMED BUILDINGS

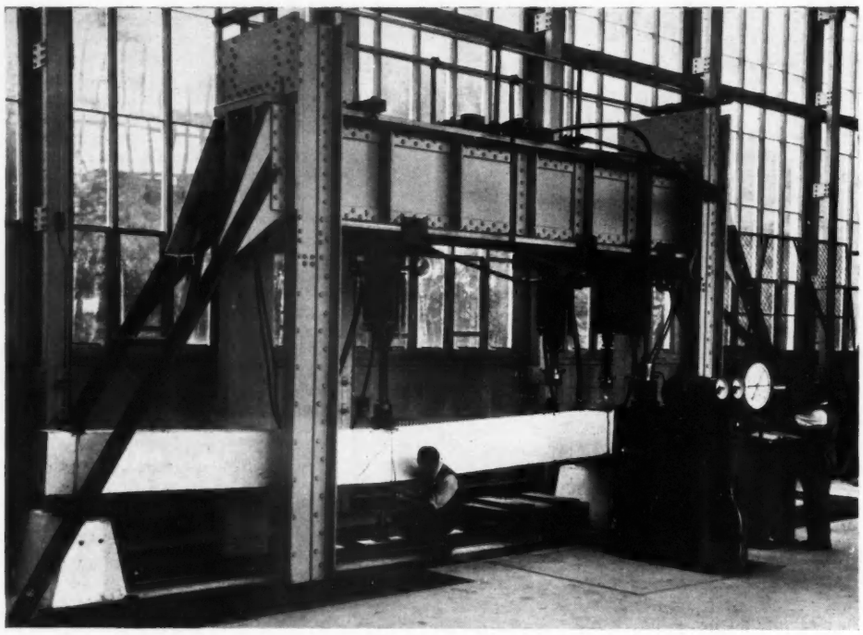
It was in 1929 that, at the invitation of the British Steelwork Association, the Steel Structures Research Committee was appointed to review the then methods and regulations affecting the design of steel structures and to recommend changes that might lead to more efficient and economical designs.

The Committee was acutely conscious of the objections to the conventional methods of design on the simple basis of assumed pin-joints between stanchions and beams, and accordingly undertook comprehensive investigations to find out how to take into proper account the design of rigidity of connections and the continuity they imposed on the structure. Tests were carried out on an experimental frame at the Station and later on actual buildings. From the results of these tests and of laboratory work, particularly by Professor C. Batho of the University of Birmingham, it was found possible to develop a method of estimating accurately the stress distribution in any frame under any loading condition. The method was not, however, suitable for normal design office use and, even with subsequent simplification, failed to become generally accepted.

In recent years another attack has been made on this problem at the Station, particularly in relation to frameworks with fully rigid joints. The method retains the use of idealised frames which are sufficiently good substitutes for the real



The present work of the Building Research Station on steel frames is concentrated on forming a design procedure that is acceptable for every day drawing-office problems. Wall panels were displayed during the openday to indicate the arguments involved.



Testing at the Station, though done under laboratory conditions, is on a scale that obviates criticism that there are differences between full-size members and laboratory specimens. The reinforced-concrete beam is being subjected to a static loading test.

frame to be designed and are amenable to analysis. This is an extension of the method which was used in the preparation of tables for the design of stanchions by the Steel Structures Research Committee. Accurate analysis has been made of a very large number of idealised frames, these being so chosen in variety and extent as to reproduce the most important characteristics of the real frame in the vicinity of the joint at which the beam or column moment is required. As a result of this comprehensive analysis it has been found possible to prepare simple design charts for direct use by the designer and these have now been published. It should be emphasised that he does not need to analyse the idealised frames himself or necessarily understand the mathematics used in the preparation of the charts. As these methods come into general use and as the results of more advanced research can be coded in form for general use, so more work will be published.

In recent years considerable interest has been shown by engineers in the possibility of design on the basis of the collapse load of steel structures, introducing the effects of plasticity. Although design on the basis of collapse is not yet practicable for multi-storey frames, it is possible and reasonable to make some allowance for the redistribution of moments that occurs at high loads as a result of plasticity, in a way similar to that adopted for many years in reinforced-concrete design. The design charts prepared by the Station do in fact make some such allowance by permitting, with some qualifications, an increase of 15 per cent. in the permissible stresses in beams, provided that the sum of the stresses at the support and at the critical span section does not exceed twice the normal permissible stress. With the methods suggested, savings of some 10 to 20 per cent. of steel may be obtained by designing building frameworks with rigid joints.

Current methods of design already make some allowance for the stiffening of the framework by the floors but, clearly, if more were known about the degree of stiffening imparted by these floors and other infillings, and by the encasements to the steel members themselves, much more realistic allowances could be made, and still greater economies in steelwork would result. It is for this reason that so much attention is also being paid at the Station to the important subject of composite action.

LOAD-BEARING WALLS

The majority of load-bearing walls are built in bricks or blocks of many types. The assessment of the structural behaviour of such walls is not a simple matter, and various attempts to gain information by making tests on actual buildings have shown how difficult it is to obtain useful design data by such methods.

Over a period of 30 years, therefore, the Station has carried out a programme of more than 500 tests on elements of load-bearing structures—mainly walls and piers and simple combinations of the two. Although many problems remain to be solved, enough has been learned already to give a sound basis for "designed" walling. Particular attention has been paid to load-bearing masonry construction. Basically, the ability of any masonry element to withstand the loading imposed upon it depends on the shape and size of the element, the strengths of the constructional units and of the mortar in which they are bedded, and the adequacy of the bond between the units and the mortar. A large number of tests have also been made, and more are still in progress, to investigate the relationship between the strength of walling and the strengths of the units and the mortar. This work has shown, among other things, that there is often no advantage in using a very strong mortar.

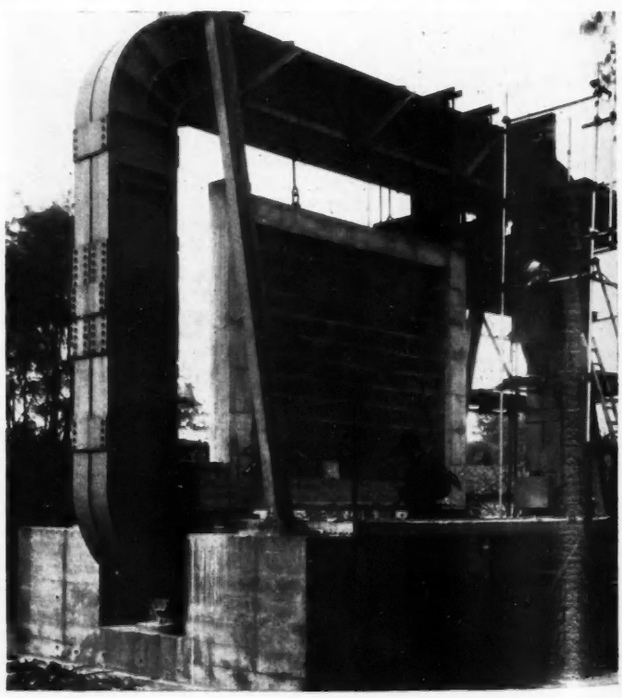
Much of the Station's work on the strength of walls has been devoted to an examination of the effects of eccentric and concentrated loads, the behaviour of cavity walls and other matters which affect the basic design of load-bearing walls as envisaged in Code CP111. Although particular reference has been made to walls built in bricks and blocks, the tests at the Station have also included many on *in situ* concrete. Reference has already been made to this work in the note on reinforced concrete.

In recent years, particularly since the formation of the Building Operations Research Unit, increasing attention has been given to practical design and constructional methods and difficulties; and the Station is now turning to the theoretical and experimental investigation of design details associated particularly with multi-storey flats of load-bearing wall construction. Other aspects of the strength of walling are involved in the general study of the interaction between the steel or concrete framework of a building and the panels used for cladding or partitioning.

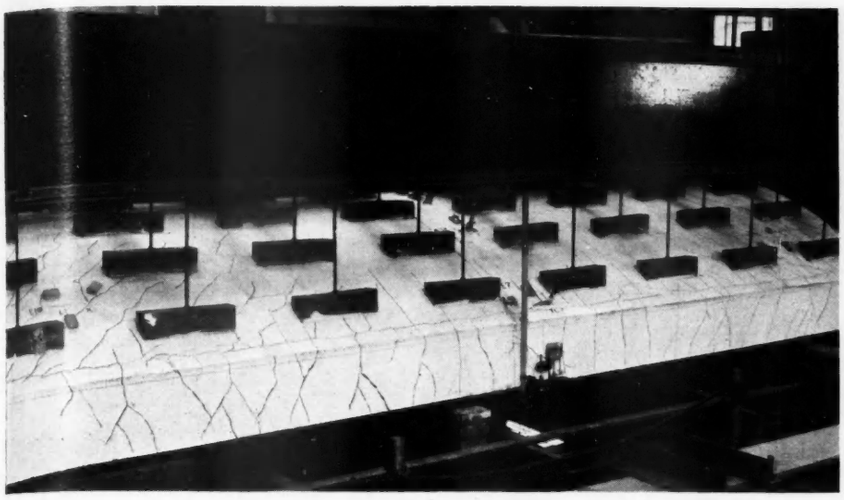
BRIDGE DECK SYSTEMS

During the past 20 years the Building Research Station has conducted investigations into the strength of various types of bridges, by means of loading tests on actual bridges, laboratory tests on models and mathematical analysis. The work has been directed towards two main objectives: (1) the assessment of the strengths of existing bridges; and (2) the development of rational methods of designing new bridges.

From the results of the tests on cast-iron girder bridges it was found possible to suggest simple methods of obtaining a conservative estimate of the strength of such bridges. These methods take account of two factors which are characteristic properties of this type of bridge: (1) load



The contribution of panel infilling to the strength of structural frames has hitherto been a neglected factor. Tests such as this of applying a racking load to a concrete-encased steel frame are giving the data necessary for the strength value of the panels to be taken into account, so permitting a reduction in the size of the frame members.



Among the fundamental experimental studies being tackled at the Building Research Station is that of concrete shell roofs. The loads are applied hydraulically so that failure of the shell causes the load to be relieved and no unnecessary damage results.

placed over one girder is partially supported by other girders; and (2) the fill and road surfacing material becomes consolidated in time and acts in combination with the girders so that the stresses in the girder for a particular load may be considerably reduced. Some of the girders removed from bridges have been saved for fatigue tests, to be made in a new machine recently installed at the Station. It is hoped that the tests may yield information on any changes in fatigue properties that may have occurred as a result of a century of traffic over the bridges.

Since the war, research on bridges has been mainly concerned with modern steel-and-concrete bridge decks. A few bridges have been tested in this programme and the most illuminating feature of the results has been the low values for the strains measured in the girders, even for fairly heavy traffic. In the laboratory, considerable data have been obtained, from tests of scale models with a linear scale ranging from one-ninth to one-half, of the structural behaviour of slab-and-girder, jack-arch, and filler-joist types of bridge. These data have indicated the reasons for the low strains in the actual bridges and have also formed the basis for suggestions for revised design methods.

The investigation has been planned primarily to determine the effect of various factors on the behaviour of bridges, with particular reference to the following aspects: (*a*) the composite action between the girders and the concrete; (*b*) the lateral distribution of load among the girders; and (*c*) the ultimate strength and mode of failure for loads at various positions. The influencing factors so far considered are: (i) the type of bridge deck; (ii) the presence of cracking; (iii) the provision of shear connectors in a slab-and-girder system; (iv) the cross beams in a slab-and-girder bridge and the tie-bar in a jack-arch bridge; (v) the degree of load concentration; and (vi) the scale of the model.

It is clear from the results of the tests that there is considerable advantage to be gained in bridge design by allowing for the true structural interaction between the girders and the concrete of the modern bridge-deck system.

In most of the tests on actual bridges, the loads were applied slowly without impact. A series of tests has, however, been made on cast-iron girder bridges with the specific object of determining the dynamic effect of vehicles crossing the bridge at their normal speeds and for a variety of road-surface conditions. The vehicles included some with solid tyres, a steam roller, and a Churchill tank. The impact factor (the ratio of the strain due to a load applied dynamically to that due to the same load applied statically) varied in most cases between 0·8 and 1·3, the commonest values being about unity. In the past, it has been usual to assume an impact factor of 1·5 or more for design purposes, but the tests show clearly that such a value is unduly high and that a more economical design can be made on the safe basis of an impact factor of 1·25 or even less.

FOUNDATIONS

The traditional approach to the design of foundations was based on the idea of being able to allocate to a given soil a "safe bearing capacity." It was believed that footings would not settle noticeably if this safe pressure was not exceeded. The only steps considered to be necessary in design were therefore to identify the soil on which the foundation was to be placed and then to adopt the appropriate safe bearing pressure. While this approach had the merit of being simple and direct, it was of course, oversimplified; it neglected such important factors as the site conditions, and particularly the nature of the strata beneath the surface, the magnitude and geometry of the foundation loads, and the type of structure.

The Civil Engineering Code of Practice No. 4, "Foundations," marks a considerable step forward from this position, since it takes into account, at least in a broad qualitative way, both the site conditions and the characteristics of the structure to be erected.

The general principles set out in the Code represent a stage of development at which the results of some of the background research have been incorporated, but further progress in research must be awaited before more specific recommendations can be given. Much of this background research has been and is being carried out at the Building Research Station. It includes theoretical analysis, laboratory research, and field studies on full-scale structures, and is concerned with three main factors: ground movements, bearing capacity and settlement.

In this application, ground movements are taken to be those that may occur independently of any loads imposed by buildings. Seasonal movements of clay due to wetting in winter and the drying action of roots in summer have been studied in detail, including their effects on houses and structures founded at shallow depths. The drying out of the ground due to the roots of fast-growing trees has received particular attention and has led to the development of the short bored-pile foundation for use in shrinkable clay areas; a system that has already been widely adopted.

Movements of the foundation soil can also be caused by processes carried out in the building. The Station has studied particularly the effects of frost heave due to the freezing of ground water under cold storage rooms and settlements under boilers and brick kilns due to the heating and consequent drying shrinkage of the underlying clay. Recommendations have been made for foundation designs giving better thermal insulation and for protective measures to prevent the movements.

The maximum load a foundation will carry depends on the shear strength of the soils within its zone of influence. To enable foundations to be designed with adequate safety, much attention has been given to the estimation of ultimate bearing capacities from strength tests on the soil, both theoretically and by model tests. The Station has contributed original work on the application of plastic theory to the analysis of foundations at a depth beneath the surface and has confirmed the results of this mathematical analysis by model tests and a few full-scale tests. In the model work, deep foundations and piles have been studied as well as surface footings. With the piles the effects of skin friction and end resistance have been separately measured. Current model work is concerned with the distribution of loads between the various piles in a pile group.

Settlement, particularly differential settlement, must be kept within limits tolerable to the structure. This is often the controlling criterion. Total settlement can be estimated from a knowledge of the soil properties and the soil strata and the size and loadings on the footings, but the factors involved are complex and close estimation is difficult. Settlement is generally considered to be made up of two components, the "immediate settlement" due to deformation of the soil without change in water content and the "consolidation settlement" due to volume reduction caused by extrusion of some of the pore water.

The differential settlement between different parts of a structure is much more difficult to estimate, since it depends not only on the factors governing total movement, but also in the layout and rigidity of the structure. Recently the Station has observed the differential settlements of selected structures and has compared the results with those predicted on the basis of tests on soil samples using conventional analytical methods. The examples studied have included bridge piers, grain silos, oil tanks and a large steel-framed building. In each case simplifying assumptions have had to be made relating to the rigidity of the structure. The results have shown that the magnitudes of the differential settlements given by the conventional approach agree reasonably well with observations. The rates of settlement, however, are usually underestimated by one-dimensional theory, and modifications of this to take account of the lateral flow of the pore water are now being developed.

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BASIC SLAG CONTROL IN STEELMAKING

Samples Standardised for Sulphur

In order to determine by the rapid-combustion method the sulphur content of basic slags (in connection with slag control in the basic open-hearth steel process), slag samples standardised for sulphur are required. For this purpose, the Bureau of Analysed Samples, Limited, Newham Hall, Middlesbrough, are issuing a series of such samples standardised by the method of analysis laid down in B.S.1121: Part 29 : 1953. The sulphur contents of the samples are :—

B.C.S. No.	Sulphur, per cent.
174	0·16
249	0·29
248	0·42

The slags are packed in bottles containing 25 gm. of each sample and may be obtained directly from the Bureau or through any of the recognised laboratory furnishers. The analyses have been made by members of the Raw Materials, Slags and Refractories Analysis Sub-Committee of the British Iron and Steel Research Association.

Guniting the main operating reservoir at Tekuma in the Negev. The water will be used to irrigate 50,000 acres for the production of basic crops of sugar beet, cotton, corn and groundnuts.

THE YARKON-NEGEV WATER PIPELINE

IRRIGATION AND FLOOD CONTROL IN SOUTHERN ISRAEL

The largest and most costly development project so far undertaken by the State of Israel—a water pipeline from the Yarkon river to the semi-desert area of the Northern Negev—has been officially opened. The project forms part of the overall scheme for irrigation and power generation for the whole of the Jordan basin, a scheme which was described in an article by Mr. P. H. Doron in our issue of July 8 (page 46). That article was accompanied by a map of the area and to which reference should be made to locate the project now being described. The River Yarkon enters the Mediterranean Sea just north of Tel-Aviv and the Negev is an area, 60 miles to the south, in the southern territories of Israel. Of the two pipelines shown on the map as leading from the Yarkon to Negev, that now completed is the western, or coastal, branch. The second, further to the east and following the foothills of the Judean Mountains, will be about the same length and will have the same capacity as the first pipeline.

The pipeline is required because most of the country's available arable land is in the south, and the major water resources are in the north and centre. In Galilee and on the Lebanese border the rainfall is between 36 and 40 in., in the centre at Jerusalem and on the coastal plain between Tel-Aviv and Haifa (mainly just north of the Yarkon) it is 24 in., whereas at Beer-sheba it is about 7 in. and in the Negev mountains only 2 in. Israel's struggle for independence depends upon cultivating every possible acre and this requires the diversion of waters to dry areas from those where supplies are available.

CONSTRUCTION AND SOURCE

Construction of a pipeline was begun by the Mekorot Water Company about 2½ years ago. (The Mekorot company is a semi-public company owned jointly by the Jewish Agency, the General Federation of Labour—Histadrut, and the Jewish National Fund—Keren Kayameth).

As a first step the Yuval Gad pipe factory, which was established in the south at Migdal-Askelon, as a joint venture of the Makorot and the Solel Boneh Contracting Company, began production in 1952. It has produced all the piping used in the line. This has included spun prestressed-concrete pipes, of 66-in. internal diameter, which constitute the major part of the line; over 21,700 such pipes, each 5 m. (over 16 ft.) long and weighing 10 tons, have been used. The Yuval Gad factory is also producing the 48-in. diameter pipes for the extensions of the line in local distribution systems; the manufacture of these smaller pipes was shown in progress in Fig. 3, on page 46 of the previous article.

The first work on the line itself was a five-mile section at the southern end. This enabled construction to go ahead immediately with local reservoirs and the distribution system. At the same time work then went ahead with laying the main line to the north. The work of construction is illustrated below; this clearly shows the excavated trench and the pipes being put into postion before bulldozers were used to push back the spoil to bury the pipeline. Simultaneously, work was carried out on the building of the underground pumping stations and of the reservoirs for storage and the regulation of water flow along the pipeline. The work of guniting the reservoir at Tekuma—it has a capacity of 45 million gallons—is shown above.

The main source of water to be tapped by the project is a small area of only 50 acres at Rosh Haayin. In this area there are over 300 natural springs and hundreds of springlets. The flow from these springs has been measured for many years now and has shown to be nearly constant throughout each year and to be at an annual rate of about 200,000 million cubic metres. Nearly all this water previously ran into the sea via the Yarkon river, but now the pipeline will divert about half this flow to the south.

PUMPING INSTALLATIONS

The Rosh Haayin springs are only about 60 ft. above sea level, whereas the land to be irrigated is at between 325 ft. and 485ft. above sea level, so that considerable pumping is required, although gravitational flow operates along lengths of the pipeline. Intermediate dams and reservoirs have also been built along the line to aid flood control and to permit the collection of winter flood water to augment the supply obtained at Rosh Haayin.

At Rosh Haayin a network of pipes has been laid underground within the area of the springs and these are used to concentrate the flow into a main bed, the sides of which are lined with concrete and project 10 in. above the water level to protect the surrounds from flooding.

From the source, three pumps, each of 600 h.p., drive the water to the first major pumping station. Here there are four pumping cells, three driven by Diesel engines each of 2,100 h.p. and the fourth by two 1,600-h.p. electric motors. These force the water through the first section of the pipeline to the Kula reservoir about five miles away and about 210 ft. above the source. Along the next section of the pipeline the water flows 12 miles under gravity to the Achisemach pumping station (near Lod), which is about 200 ft. above sea level or 70 ft. below the Kula reservoir.

The Achisemach pumps are identical to those at the first major pumping station near Rosh Haayin and are used to lift the water to 370 ft. above sea level in the Pdayah reservoir, from where it flows a distance of 48 miles under gravity to Huj, near Dorot, in the south. Here a third major pumping station has been installed to lift the water to the end of the main pipeline at Tekuma, six miles south of Dorot. The operating reservoir at Tekuma, already mentioned and shown under construction above, is the largest so far built for the project. From here the water is distributed through 48-in. diameter pipes to the Magen area, where another storage reservoir is to be constructed in the future.

THE FUTURE

As has already been said, the completed line represents only the first of two similar lines taking water from the Yarkon to the Negev,

Laying the 66-in. diameter pipeline which is to carry water from the River Yarkon to the semi-arid Negev. The pipes are of spun pre-stressed concrete.

and the way in which this project fits into the overall plan for the Jordan basin was described in a previous article. The second branch of the Yarkon-Negev line will be similar to the first, of about the same length and of the same capacity, and is scheduled for completion in 1958. It will also tap the springs at Rosh Haayin but will also carry reclaimed sewage effluent from Tel-Aviv. Since the southern terminus of this second pipeline will be somewhat higher than that of the first, four major pumping stations will be required.

Two thousand years ago, civilisation flourished in the northern Negev. War, as in other times and places, destroyed that community, but the new Yarkon-Negev pipelines are an attempt to re-establish a thriving nation in a semi-arid district liable to long periods of drought. The completed line will bring the water to irrigate 50,000 acres and the second line will enable a similar area to be watered. Wastelands of to-day will then produce basic crops—sugar beet, cotton, corn and groundnuts—to support the newly-established processing industries and urban centres, providing livelihoods and homes for 400,000 citizens.

ANGLO-AMERICAN CONFERENCE ON AERONAUTICS

REVIEW OF SOME ENGINE PROBLEMS

Concluded from page 73

We give below the third report from our representative who attended the recent Anglo-American Aeronautical Conference in Los Angeles. The papers summarised are all concerned with problems relating to the power units of modern aircraft.

LOW CONSUMPTION TURBINE ENGINES

The importance of engine weight as well as fuel consumption in turbine engines for long-range aircraft was stressed in the lecture on "Low Consumption Turbine Engines," given by Mr. A. A. Lombard, chief engineer of the Aero Division of Rolls-Royce, Limited. Reviewing the progress in specific fuel consumption over the past 10 years, he said that the large improvement of the axial-flow engines compared with the Dart was partly due to the use of higher pressure ratios and more efficient compressors, but mainly due to the basic increase in size. In the first years of engine development there was a notable reduction in specific weight, but recently the tendency had been to keep specific weight relatively constant and to reduce fuel consumption.

After developing criteria for establishing the relative importance of low weight and low consumption, Mr. Lombard went on to evaluate various design parameters. Reducing specific consumption by increasing the pressure ratio without more stages, a high temperature rise, and consequently increased weight of compressor, combustion chamber and turbine. Where the compressor and turbine were a large proportion of engine weight, as in the jet, this weight increase would be important. It was much less so for propeller turbines.

In the jet engine, the improved thermal efficiency resulting from raising the combustion efficiency was offset by an increase in jet velocity and thus a decrease in propulsive efficiency, whereas with the propeller-turbine both power and specific consumption continued to improve as combustion temperature was raised, and it was possible to see considerable development. Cooled turbines would be essential, and must be accomplished with the minimum amount of air to avoid performance penalty.

Improvement in component efficiencies could only be obtained at the expense of added weight. Future improvement lay in reducing parasitic losses—the effects of tip leakage, blade thickness, stator shroud effectiveness, etc.

Comparing various forms of turbine propulsion, Mr. Lombard said that the jet engine had its maximum thermal efficiency at about Mach 2·5, whereas the propeller turbine with a high pressure ratio obtained this efficiency at about Mach 0·6. Between these there were a range of single jet and by-pass engines. In the latter, the early compressor stages were oversize, surplus air by-passing the high-pressure section and rejoining the main stream after the turbines, resulting in a final jet of increased mass flow and reduced velocity. At the speeds considered, this gave a higher propulsive efficiency under the pure jet and allowed higher cycle temperatures.

Comparing a simple jet and by-pass engine designed for the same take-off thrust at the same combustion temperature, Mr. Lombard showed that the by-pass engine gave an improvement in range of about 5 per cent.; it was also quieter; and required less fire protection than the jet. On the other hand, in a "buried" installation it incurred a weight penalty since the spar structure was less economic; in a podded installation the weight increase would be negligible.

The propeller-turbine, Mr. Lombard said, was unchallenged for short to medium transport, but could not be justified economically at speeds above 450 m.p.h. At lower speeds, its flexibility and lower fuel consumption under stacking conditions made it attractive. The most serious problem at speeds above 425 m.p.h. was its dependence on propeller safety devices—a failure in the pitch control mechanism at high speed, causing the pitch to "fine off," could produce enormous drag and overspeed the engine by 50 per cent.

JET NOISE

Means for reducing the noise from civil jet aeroplanes at take-off and during prolonged ground running were described by Mr. F. B. Greatrex, Rolls-Royce Limited, in a lecture on "Jet Noise."

As a result of tests on the centrifugal-flow Derwent jet, the axial-flow Avon jet, and the Conway by-pass engine, Mr. Greatrex said that it had been found that the acoustic power output varied as the ninth power of the jet velocity. There was no significant difference in the jet noise from a small centrifugal engine and that from a larger axial, but the Conway by-pass engine, in which the jet temperature and velocity were lower, was some 8 to 10 decibels quieter at the same thrust. The total acoustic power output of a 10,000-lb. thrust jet engine was about 100 h.p.; after-burning would raise the output to about 1,000 h.p.

The toothed nozzle which had been tested on models at Cranfield for noise reduction, when tried on the Avon, reduced the thrust and increased the specific consumption by about 2 per cent., but a series of "corrugated" nozzles having no effect on engine performance had been found to give noise reductions sufficient to make the noise from civil aircraft tolerable, i.e., no more than that of current piston-engined air liners. It was doubtful if the noise from military aircraft with after-burning could ever be reduced to the same level.

Jet noise during ground running could be effectively silenced by a ground muffler, either semi-portable or a permanent installation, to a level no higher than the background noise in a quiet residential area, even with after-burnng in operation. The passenger in the jet airliner was unlikely to be greatly worried by jet noise which was troublesome only at take-off. Both the noise and its associated structural fatigue problems had, however, to be considered in designing the aircraft.

SUPERSONIC POWER

For propelling piloted aircraft, the turbojet with or without after-burning, depending on whether duration or range are required, is likely to be the principal method at speeds of Mach 2 to 2·5, was the conclusion of Dr. E. S. Moult, chief engineer of the de Havilland Engine Company, Limited, in his lecture on "Power Plants for Supersonic Aircraft."

Discussing the alternatives available for propulsion at supersonic speed, Dr. Moult said that owing to its essentially constant thrust the rocket offered ample excess thrust at speeds less than maximum for acceleration and climb, particularly at high altitude. It was the lightest and most compact power unit, but had the heaviest fuel consumption. The ram jet was simple and light, but suffered from lack of thrust at low speeds, and was larger in diameter than the turbojet; near its design condition it was efficient. The turbojet without after-burning gave more excess thrust at intermediate thrusts than an engine with an after-burner designed for the same maximum thrust conditions, but it would be larger and heavier than the after-burner engine. Rocket boost for short periods in conjunction with the turbojet offered tremendous gains in ceiling, speed and manoeuvrability at altitude.

Considering the turbojet engine for supersonic flight, Dr. Moult said that, owing to the effects of ram temperature and pressure at high forward speeds, a high engine pressure ratio became a limitation to output. Raising the combustion temperature produced substantial gains in thrust with a negligible penalty in fuel economy.

In a 6-to-1 pressure-ratio engine operating at 1,200 deg. K., after-burning would increase the thrust by + 105 per cent. at Mach 2 and + 219 per cent. at Mach 3. The overall fuel consumption was high and after-burning could only be used for limited periods. The engineering problem of containing high-velocity gases at a pressure of 80 lb. per square inch within a thin sheet-metal tube had been tackled by protecting the stressed outer skin with an unstressed heat shield and by careful attention to cooling and thermal insulation. To maintain constant temperature and pressure at the turbine, the final propelling-nozzle area must be continuously variable between fairly wide limits. It was desirable to expand the gases completely through a convergent-divergent nozzle.

There were two possible ways for reducing the engine frontal area: (*a*) to reduce the size of the centre nut so that a higher fraction of the frontal area was available for flow and (*b*) to increase the velocity of axial approach to the compressor. Method (*a*) implied lengthening the first-stage blades and was limited by stress and vibration considerations, and by the fact that excessively long blades could restrict the average pressure rise across the stage. Method (*b*) was limited by the Mach number relative to the rotating blades at entry. Already, the first-stage blade tips were approaching Mach 1. Because of these high-velocity conditions, it was essential that the distribution of air at entry to the compressor was perfectly uniform, otherwise efficiency would fall, blade vibration might arise, and there would be excessive local temperatures in the combustion system and turbine. Thus, the air intake was vitally important; the compressor itself, working at a lower pressure ratio, could be simpler and lighter than the subsonic compressor, although the blade stresses under the pressures and temperatures that could arise near the ground would call for considerable strengthening. Fortunately, the same problems affected the aircraft itself and it would be necessary to limit the speeds of supersonic aircraft at the lower altitudes.

To ensure minimum pressure loss in the combustion chamber, the annular type was probably

the best solution. The combustion-chamber casing would be subjected to considerable internal pressure and must be adequately strong. Already, the pressure drop across the flame tube was causing some concern about structural stability.

To handle the increased throughput, turbine blades would tend to become longer and consequently the root stresses would increase. Unfortunately, the strength of existing blade materials diminished with rising temperature. The properties of nickel-based forging alloys could be improved, but the more heat-resisting the material the more obstinate it became in hot manipulation. Cast alloys still required much work before they met all fatigue, oxidation, and thermal-shock-resistance requirements. The higher gas temperatures called for blade cooling, which must more than restore present-day metal temperatures if satisfactory strength margins were to be maintained. Turbine discs would run hotter and require improved materials. The rear-bearing temperature would depend on the thermal insulation and heat-resisting properties of the lubricant since air cooling was not very satisfactory at high flight speeds.

Other problems in the supersonic jet engine were the increased complexity of controlling and co-ordinating the after-burner fuel supply, the variable area propelling nozzle and the intake; cooling the air supply for the aircraft and crew; and instituting bench tests which would give a representation of conditions in flight.

Other papers presented at the conference were of interest only to the specialist and will not be reported. In brief, it may be noted that problems of heat transfer are becoming of increasing concern to the aerodynamicist, the engine designer and the aircraft-installations engineer; and that aircraft designers are beginning to contemplate an integrated powered flying-control system in which the pilot has only to select the direction in which he wishes to fly. In conclusion, it may be mentioned that, although the papers were largely technical, in certain instances an element of advertising was apparent and was, perhaps, more noticeable in the British contributions than in the American.

GLIDING IN A THERMAL

SAILPLANES DESIGNED FOR SOARING

By A. E. Slater

Eighteen Olympia sailplanes, of the type shown on the front cover of this issue, are among the 41 entries for the British National Gliding Championships, which open on July 23 at Lasham aerodrome, between Alton and Basingstoke in Hampshire, and continue until Bank Holiday Monday, August 1.

The word "sailplane," meaning a glider designed for soaring flight, is a rough translation of the word *Segelflugzeug*, coined in Germany, where the world's first motorless soaring flights of one, two and three hours duration were made in 1922. About that time the main features of sailplane design were established. Wings were of high aspect ratio and had a single wooden main spar, in front of which the wing was surfaced with plywood; thus the leading edge of the wing, together with the spar, formed a rigid box of D-shaped cross-section which resisted torsional loads. The rest of the wing was covered with fabric, supported by wooden ribs and an auxiliary rear spar. The Olympia wing is of this type, though the fabric cannot be seen in the photograph as the entire wing is painted—a post-war practice.

Fuselage surfaces were at first of plywood round the cockpit and fabric further aft, but later, in sailplanes of good performance like the Olympia, the plywood covering extended back to the tail.

During the 1920's practically all soaring was done where winds were deflected upwards by hills, and in order to keep up in the weakest possible winds, the rate of "sink" of the sailplane relatively to the surrounding air had to be kept to a minimum. Consequently sailplanes were lightly built to fly at between 25 and 30 m.p.h. airspeed, with highly cambered wing sections appropriate to such speeds. The main development during this period was in the direction of increased span, which helps to reduce sinking rate, and it culminated in Robert Kronfeld's "Austria," with a span of 100 ft.

THERMAL SOARING

The 1930's saw a spectacular advance in soaring technique when pilots broke away from the hills and started to soar across country by locating "thermals"—streams of warm air going up from sun-heated ground. World-wide interest was aroused, and organised gliding movements were started in many countries, including Britain. But this development set new problems for designers. At first, the thermals were thought to be so narrow that only an exceptionally nimble sailplane could be manoeuvred to keep within them; an expression of this belief was the Darmstadt Technical School's "Windspiel" of only 39 ft. span and 119 lb. empty weight.

However, it was soon found that spans of up to 60 ft. and more were no handicap; moreover, sailplanes had in any case to be built stronger and therefore heavier, because thermals lead up into the clouds, where violent currents can occasionally subject a sailplane to severe loads. So it is now the rule to design for a safety factor of 8 or more; parachutes are carried on cloud flights, and cockpits are covered in for greater comfort at such heights—the transparent hood shown in the photograph is of Perspex.

A few years before the war, a further problem was seen to require solution, and is still with us. In order to travel as far as he can across country before the thermals die out in the evening, a pilot alternately climbs in a thermal in tight circles and then makes a fast downward glide to the next thermal. But the design requirements for these two manoeuvres are contradictory. The first requires light weight, slow speed and cambered wings, as for soaring over hills, to enable the sailplane to climb nearly as fast as the surrounding air is going up; but for the second, it needs a bi-convex wing section to give a shallow gliding angle when flying at high speed, and additional weight can give still higher speed without detriment to the gliding angle.

VARIABLE WING SECTION

The answer is, of course, a compromise, and a glance at the wing-fuselage junction in the photograph will show that the under-surface of the Olympia's wing is neither concave nor convex, but approximately flat. This sailplane is a post-war version of a German type introduced in 1938 and intended as a one-class design for international use at the abortive 1940 Olympic Games.

Another example of a successful compromise, and of British post-war progress in design, is the "Sky," which Mr. Philip Wills flew to victory for Britain in the World Gliding Championships of 1952. Compared with the pre-war German "Weihe," which has the same span, 59 ft., and the same gliding angle at low speed, 1 in 29½, the Sky is slightly inferior in its rate of climb in a thermal, but more than makes up for this in the ensuing fast glide, for at 70 m.p.h. it still descends at only 1 in 20, compared with the steeper 1 in 16 of the Weihe at the same speed.

The birds, of course, get round the wing-section difficulty by altering the shape of their wings to suit changes in speed. This action has been crudely imitated in some sailplane designs by lowering a trailing-edge flap, but there is a recent German type, the HKS-1, in which the wing camber can be varied while maintaining a smooth curve; however, the necessary mechanism makes the wing both heavy and expensive.

At the forthcoming Championships at Lasham, where competitors will be launched into thermals in tow of a powered aircraft, the latest advance in soaring technique will be demonstrated by setting tasks such as flying to a distant point and back, or racing round a closed triangular course. Thus, costly retrieves by road from long flights in a downwind direction are avoided. But such tasks involve flying against or across the wind during the straight glides between thermals, so designers are being asked to provide a flat gliding angle at still greater speeds than before. Their answer has been "laminar flow."

By using special wing sections in which the greatest thickness is well back, the airflow can be kept laminar over more than half the wing before breaking away and becoming turbulent, provided that the shape and smoothness of the wing can be maintained with extreme accuracy. This is done by covering all or most of the wing with plywood, additionally stiffened, which of course puts up the weight, with a further sacrifice of low-speed performance.

LAMINAR-FLOW WINGS

Two such types will be flying in the Championships. In a laminar-flow version of the existing machine, called the "Olympia IV," the weight has risen by 40 lb. but the gliding angle has improved from 1 in 25 to 1 in 36. Another sailplane, the "Sky," has been modified into a laminar-flow "Skylark." In both the wing surface is stiffened by increasing the number of ribs. An alternative stiffening method used abroad is the "sandwich," where two layers of plywood enclose between them a filling such as a plastic "foam."

Not all sailplanes are of wood nowadays. In the United States notable success has been achieved with a series of sailplanes built entirely of metal, including the wing surface. And in England one company began building a sailplane of plastic, but became too busy to continue the work.

Finally, a new soaring technique for reaching high altitudes has been developed in recent years, using stationary atmospheric waves in the lee of mountains, somewhat like the standing waves seen in a river downstream of a submerged boulder. By this means Mr. Wills climbed to 30,400 ft. in the lee of the Southern Alps in New Zealand last December, and a world record height of 44,240 ft. has been set up in California. A project is afoot there for building a pressurised sailplane for climbing still higher into the stratosphere, as cloud formations prove this wave motion to extend upwards to at least 100,000 ft.

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TACTICAL RADAR SIMULATOR FOR AIRCRAFT

The Solartron Electronic Group, Limited, Thames Ditton, Surrey, are developing two types of apparatus with the object of facilitating the training of aircraft observers in the interpretation of information received by radar.

One of these, known as the Programmed Radar Simulator (P.R.S.) consists of a scanner designed to enable records of aircraft or ships in movement, ground, rain or sea clutter, jamming and false echoes to be displayed on a screen and thus to make the observer familiar with their appearance. The other, known as the Tactical Radar Simulator (T.R.S.) enables representations of aircraft and vessels to be introduced into the background provided by the scanner and their movements to be separately controlled.

In practice these representations can be divided between a "friendly" and an "enemy" force, thus enabling tactical training to be carried out.

DIPLOMAS IN TECHNOLOGY

DRAFT PROPOSALS ON WHICH THE NEW SCHEME IS BASED

Last week the Minister of Education, Sir David Eccles, announced that he had appointed Lord Hives, chairman of Rolls-Royce Limited, to be the first chairman of a new National Council for Diplomas in Technology. The creation of the Council and the plans for introducing the Diplomas are based on proposals that were submitted to the Minister last year by the National Advisory Council on Education for Industry and Commerce. The text of these proposals, which will have a great influence on engineering education, is given below, and editorial comment will be found in the leading article in this issue.

1. A National Council for Awards in Technology at Technical Colleges, together with Boards of Studies in (*a*) engineering and (*b*) technologies other than engineering, should be established by Deed of Trust, to create and administer awards of national currency available to students in technical colleges who successfully complete higher technological courses approved by the Council for the purpose of the awards.

2. The Awards should be Diplomas in Technology, with Honours for distinguished performance in the examinations. The name of the particular technology in which the award has been gained could be included in the title of the award if this is considered appropriate, e.g. Dip. Tech. (Engineering). The awards would not confer a professional qualification but would be designed to provide at the first level an educational qualification comparable in value to a university first degree. The Council shall establish an appropriate post-graduate award (or awards) as soon as may be convenient.

The awards should be available only in respect of courses in technical colleges approved by the Council in accordance with the standards set out in paragraph 3 (*b*) below, and there should be no exemption from this requirement.

3. Functions

(*a*) *The Council*

The Council would have general responsibility for creating the awards and administering them. They would act as trustees, co-ordinate the work of the Boards of Studies and adjudicate on matters referred to them by the Boards. They should have power to create additional Boards of Studies if necessary and to provide for the representation, on any existing Board, of professional institutions not already represented thereon. They should also be authorised to appoint sub-committees with power to co-opt.

(*b*) *The Boards of Studies*

There should be two Boards of Studies in the first place, one in engineering and one in technologies other than engineering. The Boards would be responsible to the Council for all matters concerned with the approval of courses, the standards of the awards and the conduct of examinations. This would include such matters as:—

(i) The curricula and syllabuses of courses proposed by the technical colleges for the awards and, in particular, the standard of the college work in pure science and in technologies related to the courses for which approval is sought;

(ii) The standard of admission to the courses;

(iii) The qualifications of the teachers conducting the course;

(iv) The accommodation and equipment available to the courses; and

(v) The principal conditions for the conduct of examinations including the approval of external examiners to act with the teaching staff of the colleges providing the courses.

4. Constitution

(*a*) *The Council*

The Council should be an independent self-governing body and should include members of Boards of Studies, as provided below, and other persons of the highest standing in the field of technology. They should serve as individuals and not as representatives of particular organisations.

The Council should be authorised to appoint sub-committees with power to co-opt, and to delegate authority to them.

The Chairman of the Council should be appointed by the Minister of Education and the Council should be composed as follows:—

Five persons appointed by the Minister of Education, four of them for their eminence and distinction in the field of technology and one for his knowledge of local education authority administration.

Three persons appointed by each of the Boards of Studies from amongst their members, each Board to include at least one member of the teaching staff of technical colleges in the three persons it appoints.

Thus, in the first instance, the Council would consist of the Chairman and eleven members appointed as above.

Assessors should be appointed by the Minister of Education and by any other Goverment Departments invited by the Council to do so.

(*b*) *The Boards of Studies*

(i) *The Board of Studies in Engineering* should be appointed in the first place by the Minister of Education, and subsequently by the Council, on the nomination of the bodies concerned. It should be composed of:—

10 members of the teaching staffs of technical colleges, nominated by the Association of Principals of Technical Institutions and the Association of Teachers in Technical Institutions.
1 member nominated by the Institution of Chemical Engineers.
2 members nominated by the Institution of Civil Engineers.
2 members nominated by the Institution of Electrical Engineers.
1 member nominated by the Institution of Gas Engineers.
2 members nominated by the Institution of Mechanical Engineers.
1 member nominated by the Institution of Mining Engineers.
1 member nominated by the Institution of Production Engineers.
1 member nominated by the Institution of Structural Engineers.
1 member nominated by the Royal Aeronautical Society.
1 member nominated by the Royal Society.
5 members nominated by the Minister of Education to represent industry and other fields, including the universities.
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(ii) *The Board of Studies in Technologies other than Engineering* should also be appointed in the first place by the Minister of Education, and subsequently by the Council, on the nomination of the bodies concerned. It should be composed of:—

10 members of the teaching staffs of technical colleges, nominated by the Association of Principals of Technical Institutions and the Association of Teachers in Technical Institutions.
1 member nominated by the Institute of Builders.
1 member nominated by the Institute of Fuel.
1 member nominated by the Institute of Physics.
1 member nominated by the Institution of Metallurgists.
1 member nominated by the Institution of Rubber Industry.
1 member nominated by the Institution of Structural Engineers.
1 member nominated by the Plastics Institute.
1 member nominated by the Royal Institute of Chemistry.
1 member nominated by the Royal Institution of Chartered Surveyors.
1 member nominated by the Royal Society.
1 member nominated by the Textile Institute.
5 members nominated by the Minister of Education to represent industry and other fields, including the universities.
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(iii) The constitution of any other Boards of Studies which may be set up should be determined by the Council, who should appoint the members.

(iv) All the members of the Boards of Studies would serve in an individual capacity and not as representatives of the bodies nominating them.

(v) The Boards of Studies would be authorised to set up sub-committees, including subject panels, with power to co-opt.

5. Term of Office

A period of five years is suggested as the normal term of office of the members of the Council and a period of three years as the normal term of office of the members of the Boards of Studies. Any arrangements which are made for the retirement of members and the election of others should be such as to secure reasonable continuity.

6. Secretariat

The Secretariat should be appointed by the Council and should serve the organisation as a whole.

7. Finance

Some income may be expected to accrue from fees, but it is unlikely that this income would be sufficient to meet the whole of the expenditure necessarily incurred by the Council and some form of Exchequer subvention would be necessary, at any rate at the outset.

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ELECTRICAL INSULATION WITH HIGH THERMAL CONDUCTIVITY

A silicone-based insulating material has been produced by the Allis-Chalmers Manufacturing Company, Box 512, Milwaukee 1, Wisconsin, U.S.A., and is marketed in this country through Allis-Chalmers Great Britain, Limited, Totton, Southampton. The material is called Silco-flex, and has a number of advantages for the insulation of electric motors. The dielectric and mechanical properties do not change significantly with ageing at high temperature over long periods of time. When applied to a cable to give a thickness of 0·074 mils. and aged for 8 weeks at 250 deg. C., Silco-flex still had a dielectric strength of 530 volts per mil. unflexed; moulded samples had a strength of 470 volts per mil. after one year of ageing at 250 deg. C. Moisture resistance is shown from an insulation resistance test carried out on cable insulated with Silco-flex; after 125 days of immersion in boiling water the insulation resistance was in the range of 2,500 megohms per 1,000 ft. at 100 deg. C. An advantage of its use in motors is that the thermal conductivity is high and therefore heat can be dissipated from the motor more readily.

Silco-flex is made by compounding pure silicone-rubber gum with so-called "silica soot," which is produced by burning silicon tetrachloride in the presence of combustible gases. The insulation material is applied by continuous taping with a binding material of the same chemical composition, which vulcanises into a uniform mass with application of heat and pressure.

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ALUMINIUM-ALLOY CONCAVE-POINTED RIVETS

We regret that an error occurred in the first sentence of the article under this title which appeared on page 79 of last week's issue. The sentence should have read: "It is well known that the necessary cold driving of aluminium-alloy rivets requires larger forces than are practicable if large diameter rivets of conventional design are used."

CO-ORDINATED USE OF MINERALS

London Conference in September

Proposals have been put forward from time to time for establishing an organisation in the United Kingdom comparable to the Office of Materials Mobilisation which has been set up in the United States. It is felt by many persons connected with the development of the mineral resources of the British Commonwealth that some form of co-ordination of effort at each stage of production is desirable, in order to conserve supplies and expand output to the best advantage. With the object of providing an opportunity for these aims to be fully discussed, the Institution of Mining and Metallurgy has arranged to hold a meeting at the Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2, on Thursday, September 22, when a series of six papers will be presented.

The symposium is also intended to allow for a fuller discussion of suggestions contained in a paper entitled "Mineral Resources Strategy," which was read by Mr. D. A. Oliver, C.B.E., Director of the Birmingham Small Arms Group Research Centre, Sheffield, at a conference on research and industrial productivity organised by the Department of Scientific and Industrial Research and the British Productivity Council, and held in London in November, 1954. Mr. Oliver expressed the view that the productivity of minerals would be increased if greater co-ordination could be arranged between all interested parties, including geologists, mining engineers, mineral-dressing specialists, mining and financial houses, manufacturers, users, local authorities, and the Government.

Two sessions, each of two-and-a-half hours' duration, will be held at the forthcoming conference, commencing at 10 a.m. and 2 p.m., respectively. The papers will comprise "Mineral Resources Strategy: A Plea for a Fresh Approach," by Mr. D. A. Oliver; "Mineral Development and Research in the United States and Canada," by Mr. J. Sandor; "The Mineral Industry in East Africa," by Dr. K. A. Davies; "How Canada Aids Its Mineral Industry," by Mr. R. J. Traill; "Economic Considerations in a British Mineral Resources Policy," by Mr. L. B. Pinnell; and "Proposals for a Central Ore-Dressing Laboratory," by Dr. M. G. Fleming.

The meeting will be open to all interested persons, and applications to attend should be sent to the secretary of the Institution, Salisbury House, Finsbury-circus, London, E.C.2. A limited number of advance copies of the papers will be available free of charge.

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CAMERA FOR USE WITH OSCILLOSCOPES

A camera produced specially to record cathode-ray oscilloscope images has been introduced into this country by Polarizers (U.K.) Limited, 186 Acton-lane, London, N.W.10.

Designed for still and continuous motion photography on standard 35-mm. film, the Fairchild Oscillo-Record Camera is easy to set up and operate, and produces clear photographic records of high-speed transients, stationary patterns of periodically returning phenomena, or any type of phenomena which can be put on a cathode-ray oscilloscope. The camera offers the only satisfactory method of studying non-recurring phenomena which occur either too rapidly to permit adequate visual study or too slowly to give any continuity, as well as combinations of very slow-speed phenomena with occasional high-speed transients.

A special adaptation of the Polaroid-Land principle of developing a print in one minute is embodied in the camera. This enables laboratory work to proceed without the interruptions or long waiting periods necessary when conventional film is used.

Labour Notes

SHORTER HOURS WANTED

As is usual at this period of the year, a number of trade-union conferences have recently been held. One or two more are still to come. As is also the common practice, delegates at these conferences have sponsored a variety of new claims on the employers, among which have been several demands for higher wages.

With the heavy increase in the price of coal and the upward trend in living costs, which, almost inevitably, will result, these wage demands are likely to be but the forerunners of a number of others.

Another outstanding feature of recent conferences has been the insistence on shorter working hours and longer holidays. It is noteworthy that the Amalgamated Engineering Union, the Electrical Trades Union and the Transport and General Workers' Union, for example, have each asked for the introduction of a 40-hour working week in place of the present standard week of 44 hours.

It may well be that, with the greater difficulty of securing still higher rates of wages, a feeling has been growing among trade unionists that the introduction of a shorter working week would lead indirectly to greater overall earnings. The fact is that the average number of hours worked by men at the present time is greater than 48 a week and, if a 40-hour week were introduced, there would usually be a balance of eight hours a week, in place of the existing four, to qualify for overtime rates. It is true hat there has been some agitation for a reduc- on in the working of overtime, notably in the Amalgamated Engineering Union and the Electrical Trades Union, but this objective is hardly likely to be popular with the rank and file.

T.G.W.U. CONFERENCE

Although, in general, the 870 delegates attending this year's biennial conference of the Transport and General Workers' Union agreed with the views expressed by the union's executive committee, they were adamant on the question of the 40-hour week.

As stated in Weekly Survey, the five-day conference took place at Blackpool last week and the delegates, in spite of pleas by the executive committee that the present time was not an opportune one, decided to inaugurate a campaign for the early introduction of a five-day 40-hour working week, without any diminution of pay. This led Mr. A. E. Tiffin, the union's new general secretary, to remark, rather tartly, that it was hypocrisy to talk of a 40-hour week, when what was really in mind was increased bonuses and premium rates for overtime work.

It might be the case that some industries could accede to a shorter week, but, even in these cases, he trembled to think what might happen if the negotiations succeeded. There was work to be done and it could not be carried out in a 40-hour week. There just were not sufficient workpeople. If the delegates were in favour of an increase in basic wages, why, Mr. Tiffin asked, not say so?

He reminded the delegates that the unions were now the fifth estate of the realm and that when they wanted a shorter week they could tell the employers to give it to them and they would not have to go cap in hand to get it.

Other speakers maintained that a shorter week should be part of the union's established policy, although some of them recognised that such a concession would take years to achieve. The resolution was carried by a show of hands.

WAGES AND PROFIT SHARING

A composite resolution combining 18 separate motions on wages, prices and profits was presented at the same session and had the support of the executive committee. Its terms were vague and, although there was a strong hint of a new wage claim being put forward, no precise figure was suggested.

After complaining about the Government's "policy" of increasing prices and dividends, the resolution demanded immediate action to reduce the cost of living, and thus led up to its real objective, which was expressed by the phrase that "industry must be prepared to face up to these upward adjustments in wages as these can be regarded as essential at this time."

On the opening day of the conference, an invitation was extended to the 10,000 or so dockers at the Northern ports who had strayed from the union to return to the parental fold. It was coupled with a firm warning that the men would find no one else to shelter them.

In his address to the delegates, Mr. Edgar Fryer, the chairman of the conference, began by condemning all irresponsible and unofficial movements in the unions, which, he said, could cause nothing but confusion among trade unionists. He advised members to view with caution the growing tendency of firms to offer their shares to employees as gifts, or at favourable prices. These offers sometimes took the place of adequate wages and better conditions and, at other times, might be intended to bind workpeople to a particular organisation.

A wide variety of subjects were discussed at other sessions of the conference. Much time was spent at one session on a discussion of automation. The general view appeared to be that the term was an ugly one and that it did not really express a new idea. There was nothing to fear, however, provided that workers had their share of its achievements.

AGITATORS CONDEMNED

Writing under the heading "Scabs, Blacklegs," in the July issue of *Man and Metal*, the official journal of the Iron and Steel Trades Confederation, Mr. Harry Douglass, the Confederation's general secretary, states that, in the whole history of the labour struggle, probably the most vicious label which could be attached to men is that given in the title to his article.

Traditionally, these epithets had pilloried the traitor in the battle for a decent standard of living and a sense of security, but to-day the strange situation existed that a man carrying out the instructions of his elected leaders, and loyally supporting his union's policy, had the words flung at him with a scorn born of belligerent ignorance, and an utter disregard for the future of the trade-union movement.

Mr. Douglass, who is a member of the Trades Union Congress General Council, adds that unofficial strikes of men, persuaded by specious promises to defy their constitutionally-elected leaders, and strikes arising from inter-union disputes, could only be calculated to shoot down the prestige of trade unionism in flames which warm the hearts of left-wing extremists and their disruptive sympathisers.

REDUNDANCY IN AIRCRAFT INDUSTRY

Threats of redundancy were given as the reason for a protest meeting held by some 5,000 workpeople of Sir W. G. Armstrong Whitworth (Aircraft), Limited, at Coventry, on Thursday of last week. The demonstration was attended by employees from both the firm's factories.

It had been felt for some time by these employees that Coventry had not been securing its fair share of aircraft contracts, and the Government has been held responsible for the decline in the number of orders. One of the leading shop stewards at the firm told the gathering that the management had declared that about 1,500 skilled men would be redundant by April, 1956. It was expected that the men would be laid off at the rate of between 50 and 60 a fortnight and that notices for the first group were likely to take effect from August 5 next.

Eventually, a resolution was passed asking the Government to use money, saved by the curtailment of the rearmament programme, on the development and expansion of the civilian-aircraft section of the industry.

Unemployment in Coventry, it may be noted, is 0·2 per cent. of its insured population and among the lowest in the country.